

RADIOLOGY

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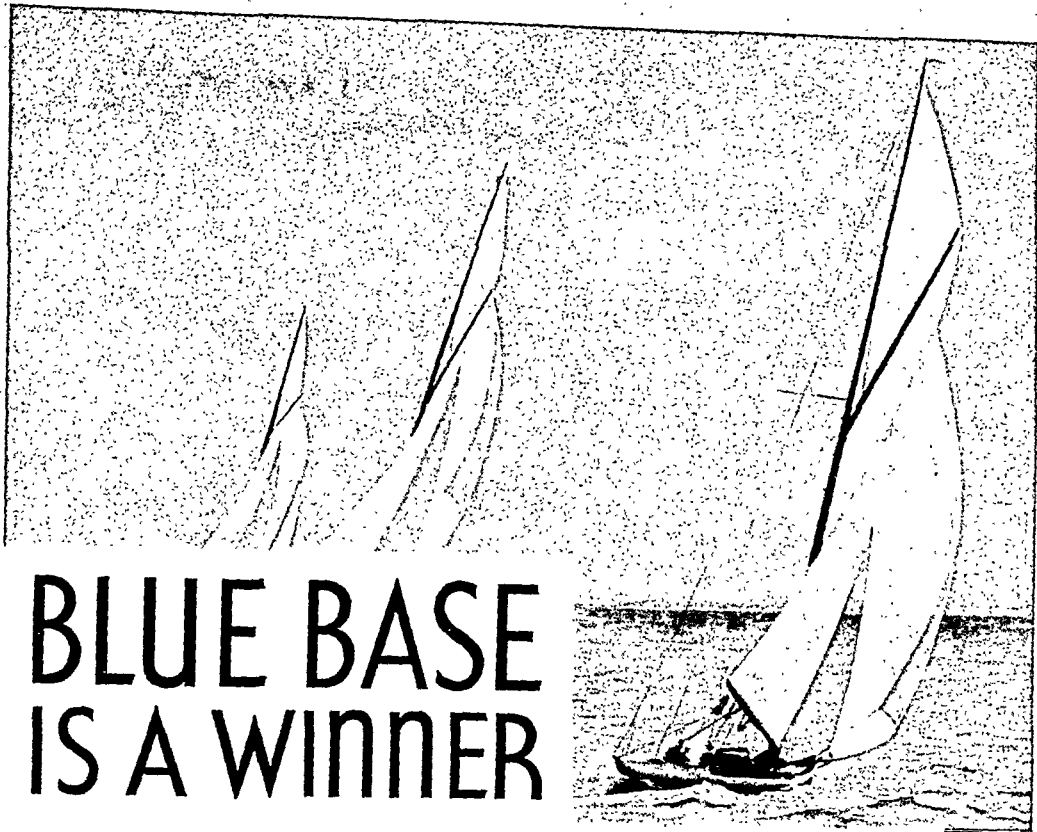


JUNE, 1933

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Number 6

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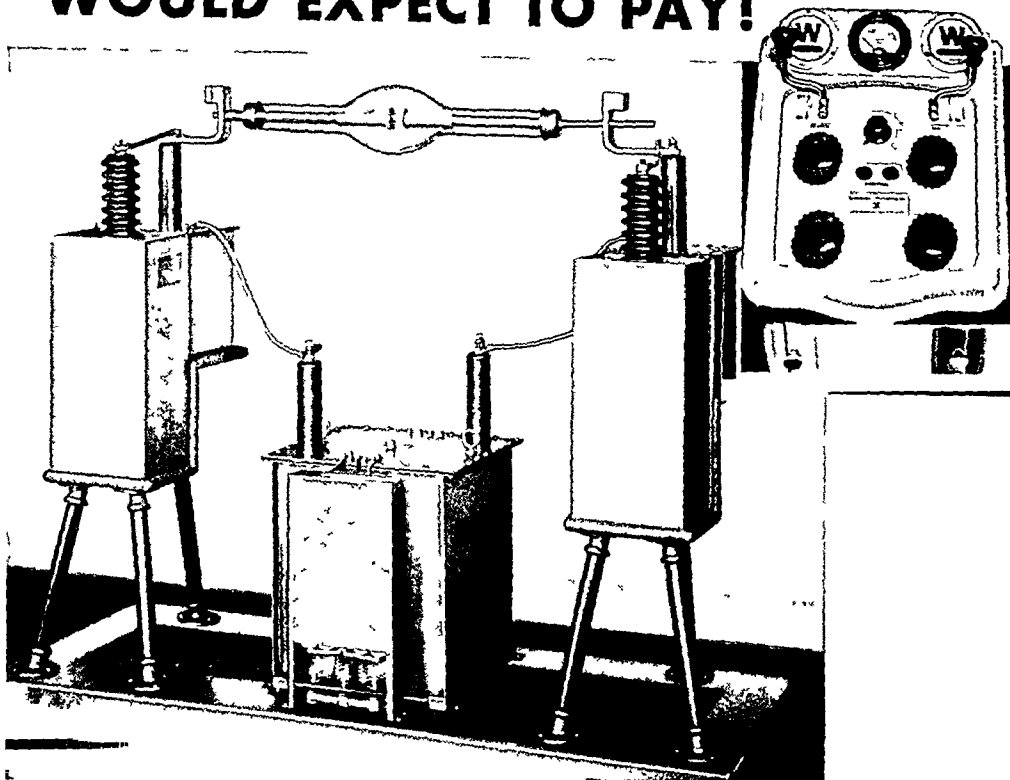
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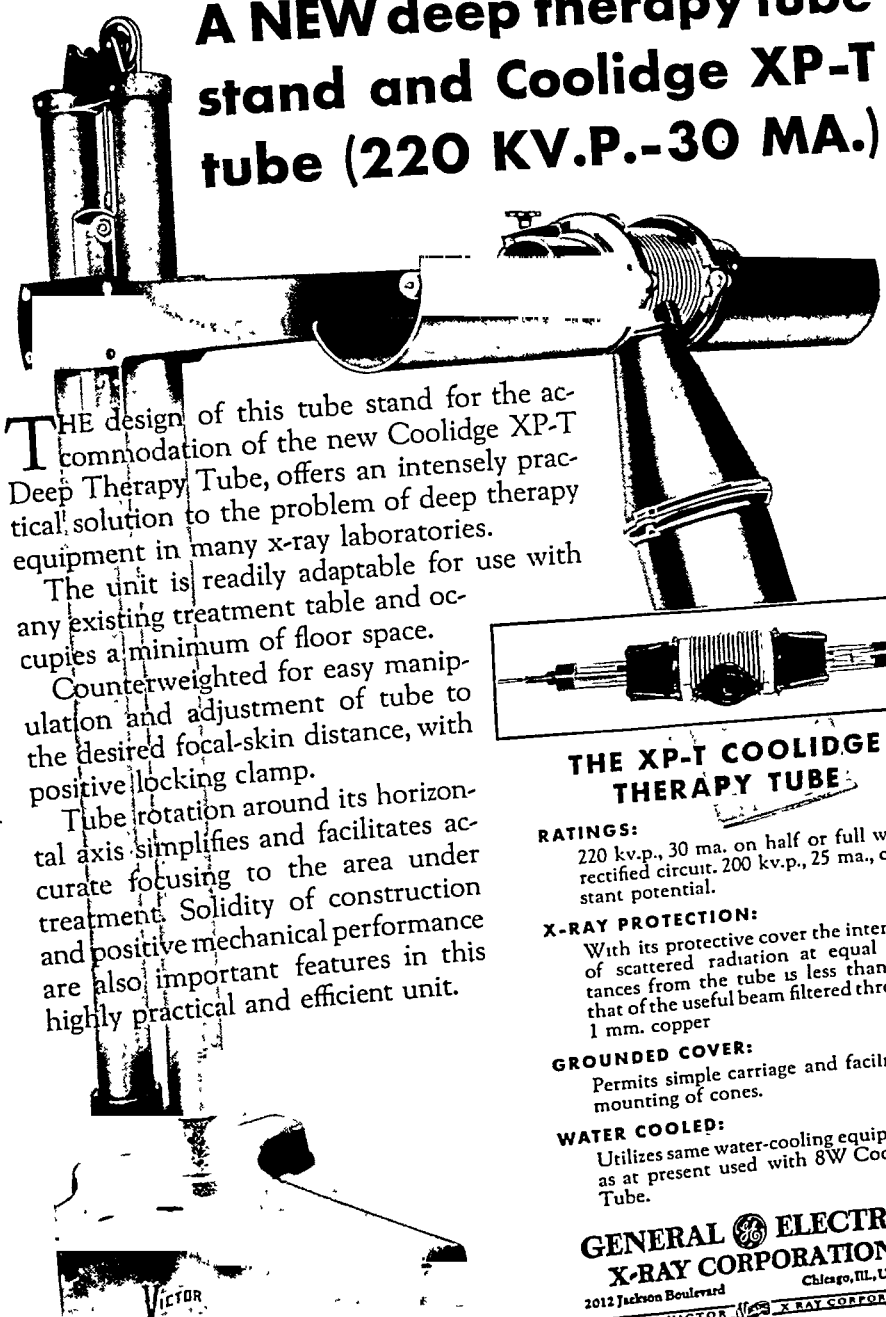
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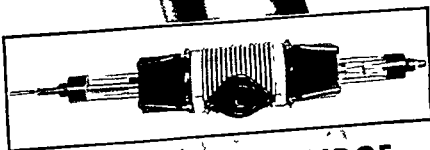


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VOL. XX

JUNE, 1933

No. 6

THE SCOPE OF ACTIVITY OF THE ROENTGENOLOGIC PHYSICIAN¹

ILLUSTRATED BY TEN ULCER PROBLEMS

By LEWIS GREGORY COLE, M.D., NEW YORK CITY

THIS title simply indicates a new phase of the old problem of "the status of roentgenology in the field of medicine" and, particularly, the standing of the roentgenologist compared with his colleagues in other specialties. The status of roentgenology has been under discussion for the last three decades. An early phase of this is well illustrated by a personal incident. Before I accepted my first appointment as roentgenologist to the Roosevelt Hospital, my interne associates labored zealously with me to prevent me from forsaking the desired career as a surgeon to become a so-called "medical photographer," because, at that time, the principal specialist in this line in New York was not a physician, and the x-ray plates were made throughout the city almost exclusively by the hospital engineer, apothecary, photographer, elevator boy, or bell hop. Only occasionally did a doctor associate himself with the department of roentgenology in a hospital, and then he condescended to do so only as a stepping stone to some more dignified position on the staff. George Johnson, who was often referred to as the "court jester" of the old Society, summarized the situation by saying that "the specialty of roentgenology had been born

with a breech presentation." To me, it would seem rather that the older specialist rather looked upon the newcomer as an illegitimate sister.

The highly complicated technic of radiography required some knowledge of electricity for the operation and construction of apparatus and some knowledge of the principles of photography for the development of the plates. These factors soon caused roentgenology to become a specialty and, in those early days, the ability to make satisfactory roentgenograms was the chief function of the roentgenologist. Soon after he was able to obtain satisfactory roentgenograms, it became evident that the findings observed in them did not correspond with our preconceived ideas of what they should show. My personal interest in the subject of roentgenology was elicited to prove that a fracture of the middle third of the tibia and fibula, which, as an embryo surgeon, I had treated, was not in as bad position as the roentgenogram showed it to be. For more than a year before I ever made an x-ray examination myself, I worked in the department of anatomy under Hunnington, on shadows of fractured, articulated bones, to prove that the malposition observed in this first roentgenogram that had been made for me was due to "skiagraphic errors,"

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931

which, subsequently, became the title of one of my first papers. The function of the roentgenologist then began to include the reading of these x-ray findings as observed in the plates, first, only as a description of what he saw and, later, interpretations of these gradations of shadows in terms of pathology. The gradual development of roentgenology occurred in the following order: (1) foreign bodies; (2) fractures; (3) kidney stones; (4) pulmonary tuberculosis; (5) infected accessory sinuses; (6) cancer of the stomach or colon; (7) ulcer of the stomach; (8) post-pyloric ulcers; (9) gallstones and gall-bladder dye procedure followed each other in rapid succession.

Advance in technic and interpretation, with rare exceptions, was largely the result of the activity of the roentgenologist, rather than other specialists. In the early days of roentgenology it was difficult for the attending physician to convince the patient of the necessity of having an x-ray examination. Later the confidence of the laity in the x-ray diagnosis led them to demand such an examination, even when it was not suggested by the physician. Often the results proved embarrassing to the physician, revealing kidney stones, pulmonary tuberculosis, cancer, or ulcer in patients he had not even suspected of having these diseases. Therefore, in those early days, the specialty of roentgenology developed rapidly. The engineer, the medical photographer, the apothecary joined in the procession and either developed commercial laboratories or occupied positions of responsibility as roentgenographers in reputable institutions, often splitting fees with the men who sent them work or with the hospital which practised medicine and used the income from this source to make up the deficits in less lucrative laboratories.

The commercial x-ray laboratories primarily organized by these non-medical men not only split fees or gave rebates to physicians sending patients to them, but they

openly advertised this fact by a monthly supply of blotters. It was astonishing to note what reputable physicians would use such a blotter to blot the indorsement on a monthly check sent them by these laboratories without any request on their part. This fee-splitting with the commercial laboratories is an act which often causes the first offense of a reputable physician in the vicious habit which later extends to sister-specialties. I rejoice that fee-splitting among reputable roentgenologists is not as common as in some other specialties. The rapidly increasing demand on the part of patients to have roentgenological examinations, and the frequency with which unsuspected lesions were diagnosed by this method, caused consternation in the camp of other specialists because of the loss of prestige, and because of the apparent lucrativeness of this procedure. Therefore, members of other specialties became the ready prey for the x-ray apparatus salesman who supplied small apparatus such as could be installed in any doctor's office. In fact, these firms were not particular whether the customer was a doctor or not. This indiscriminate distribution of x-ray apparatus to those who had no experience in this highly technical specialty was like giving a pair of high forceps to a midwife. Patients who applied for medical advice were deceived by these physicians and were made to believe that they had had an adequate x-ray examination, whereas the doctor who merely looked at them through the fluoroscope had had no previous training in roentgenology. Such practices temporarily encroached on the field of the competent roentgenologist, but permanently reflected discredit upon the ability of the doctor who adopted them. The patient who learns by subsequent examination that such a doctor knows nothing about x-rays, suspects that this doctor knows no more about clinical medicine than he does about roentgenology.

However, such dumping of small x-ray

apparatus on the general medical practitioner by large and reputable manufacturers has led to consternation among roentgenologists as to the present status and future possibilities of roentgenology as a specialty. The demand for competent roentgenologists has far exceeded the supply, due, in part, to the rapid development of the specialty because of its value in solving many problems of diagnosis and treatment. This is a condition which could not be wondered at, but the principal reason for the lack of supply of competent roentgenologists is the fact that the medical colleges and universities were not only slow in forming courses for adequate undergraduate instruction, but were also slow in giving post-graduate instruction. The excuse of the medical faculty of such institutions for not giving adequate undergraduate instruction is the insufficient time for the study of essential subjects and they consider roentgenology an unimportant one, even though it plays some part in the diagnosis, differential diagnosis, or treatment in more than half of the cases presented to them. In many of the institutions in which some instruction is given in roentgenology a concerted effort is made to distribute the roentgenologic work among the various departments so that its immense value in diagnosis shall not embarrass the older sister-specialties. In this way, the x-ray diagnosis is kept under control so that it does not compete with the older clinical methods in the diagnosis of lesions and, particularly, in the other problems of medicine.

This competition between clinical and roentgenologic methods was well illustrated in the problem or controversy concerning the relative value of the clinical diagnosis of tuberculosis compared with the roentgenologic diagnosis. It was not until Lawson Brown was converted and became a Saul of Tarsus that his preaching of the gospel of roentgenology converted so many of his clinical colleagues. Roentgenology has now

become the foundation upon which not only the diagnosis but the classification—the extent and activity of the process—is builded.

The consternation among roentgenologists as to the status of roentgenology has been indicated by casual remarks in and out of medical meetings since the very birth of this specialty, but its aggravation at the present time is denoted by the fact that it was the theme of two of the invited papers at the Third International Congress (Paris, 1931), where it was discussed by Dr. Lynham and by the speaker. Furthermore, it was the theme of the Caldwell Lecture at the 1931 meeting of the American Roentgen Ray Society. Haenisch came all the way from Hamburg to emphasize the significance of the unstable status of roentgenology abroad, especially in his own country, and to warn us of the same approaching danger in this country, but he offered no suggestion as to a means of escape from this danger. On the other hand, Dr. Lynham, of London, suggested a roentgenologic institute, similar to that in London, composed of physicians, physicists, technicians, and even manufacturers, to work in harmony in attempting to prevent the evil practices which threatened roentgenology as a specialty. I am not so much concerned as to whether or not roentgenology continues as a pure specialty as I am concerned with the grade of roentgenology practised—by the physician, as a clinician, by the roentgenologist, as a specialist, or by specialists in other lines, using it in their own work, provided only that they have prepared themselves by technical training and by ample instruction in interpretation of the roentgenological findings. I am, however, vigorously opposed to the installation of an x-ray machine in a doctor's office for advertising purposes, wherewith he makes only an inadequate, or even fake, x-ray examination to satisfy the demand of the patient, and, perhaps, to get an additional fee to help him pay for the apparatus.

Many of the younger men who entered

the field of roentgenology as a specialty are unable to obtain an adequate training, and this, together with the fact that they are young, prevents them from enjoying the respect which has finally been bestowed upon some of the older roentgenologists. During the latter part of this period of the development of roentgenology as a specialty, two schools have become manifest. One school limits its scope to the making of roentgenograms or fluoroscopic examinations, describing the findings so observed and, in some cases, interpreting these findings into a diagnosis. In many cases, however, these roentgenologists simply report the findings as "filling defects of the stomach" or "an area of density in the lungs" or "cloudiness in the antrum," etc., leaving the interpretation of these findings to the clinician to whom the report is sent. Such roentgenologists shift the responsibility of the roentgenologic diagnosis to the clinicians, rather than assume it themselves. The other school of roentgenologists applies the roentgenologic findings as observed, either fluoroscopically or roentgenographically, to the solution of many problems of medicine and surgery. Exceptions which the first school makes to the rule of simply reporting roentgenologic findings (and, possibly, giving a diagnosis) are evidenced in the following procedures. For example, a shadow denser than the bone is evidence of a metallic foreign body and, if this is the size and shape of a bullet, it results in the diagnosis of a bullet. Diagnosis ends here but localization, especially by fluoroscopic control during an operation, becomes more than a diagnostic problem—it becomes an important factor in surgical treatment; perhaps even more important than the cutting by the surgeon himself. Again, the position of the fragments in a fracture becomes the most important phase in the surgical treatment and either the roentgenologist or the surgeon must make the decision as to

whether these fragments are in a satisfactory position or not. This decision must, in turn, be based upon the roentgenologic findings. Whether this is done by the surgeon or the roentgenologist is not so important, but roentgenology becomes the prime factor in the solution of this problem. Let us cite another example. A kidney stone is readily diagnosed, for instance, but whether it is of size or roughness so that it will not pass becomes a roentgenologic problem. Roentgenologic findings in pulmonary tuberculosis are so characteristic that they have not only become the basis of diagnosis, but, thanks to Lawrason Brown, they also have become the basis for classification as adopted by the American Tuberculosis Association. This takes the field of roentgenology beyond diagnosis and makes it an important factor in prognosis and indication for treatment. Well organized cicatricial, or even calcified, tubercles constitute the diagnosis of pulmonary tuberculosis, but these lesions should be definitely differentiated from the soft, mushy, snow-flake-like appearance characteristic of the subacute, exudative lesion. Almost complete resolution of such an acute exudative process as this was not even suspected until revealed by a series of roentgenograms made at short or long periods of time. Therefore, diagnosis, prognosis, life history of the disease, indication for treatment, and the results of treatment may be determined by this method of examination. Whether these findings are to be interpreted by the roentgenologist or the clinician is not important as long as either is qualified by experience to interpret the findings. Thus, many of those who are advocates of the simple, safe, and sane school have been forced beyond their ramparts by this inevitable trend of progress.

This trend of progress did not come of itself. The older men will remember the bitter opposition to the roentgenologic diagnosis of pulmonary tuberculosis, even by our

own specialists. This antagonism began at the 1907 meeting of the American Roentgen Ray Society, at Cincinnati, and raged for several years. Even within the memory of the younger men, it has met with opposition from clinicians. The bitter controversy among ourselves concerning the value of roentgenologic findings in the diagnosis of duodenal ulcer centered at the Boston meeting of the Roentgen Ray Society, in 1913. It did not come without bloodshed, not as literal as the Battle of Bunker Hill, but with the same spirit. Now we may ask ourselves if these days of roentgenologic advance as applied to the problems of medicine have ceased. Must we now be content to relate these as historical events, or are we still within the era of history-making as roentgenology is applied to the problems of medicine? Those who adhere to the simple, sane method of reporting only findings and, possibly, diagnosis, may be called the conservative school. Those who hold the other point of view may call themselves the progressive school. The conservatives will call them radicals and within their ranks will be found all shades of radicalism, from the pale pink (just off the snowy white) of conservatism to the fiery red of radicalism. However, even the extremes to which we to-day point will not compare in radicalism to many statements of the past: For example, in 1904, that one can make a diagnosis of renal calculus with sufficient accuracy so that it may influence the diagnosis or treatment of the lesion; in 1907, that the x-ray will in time prove to be the important factor in the diagnosis of tuberculosis; in 1908, that the diagnosis of cancer of the stomach can be made with a greater degree of accuracy by this method than by all other methods combined, or, in 1913, that by the x-ray one can diagnose the new disease, duodenal ulcer. (Up to five years before that time it was practically unknown and had escaped the detection of world-renowned pathologists.) Compared with these

statements—so radical in *their* day—the statements of to-day will be lily-white or tinged only with the slight color of progress. This finding brings us to the subject of this communication, namely, the scope of the activity of the roentgenologic physician.

Any one of innumerable lesions might be used to illustrate this subject, but one is selected in which I am especially interested, namely, gastric ulcer. This is, also, selected because it has been the center of great controversy which continues to involve all phases of the ulcer problems. What are these ulcer problems? There are ten of them.

1. Diagnosis—Has the patient got an ulcer?
2. Treatment—Should it be treated medically or surgically?
3. Malignancy—Do benign ulcers frequently become malignant?
4. Etiology—
 - (a) Why does the ulcer develop where it does?
 - (b) Why does the ulcer develop when it does?
5. Pathogenesis—How does the ulcer develop?
6. What is the life history of an ulcer?
 - (a) Treated medically.
 - (b) Untreated.
7. Process of repair—How does the ulcer heal?
 - (a) By granulation tissue.
 - (b) By cicatricial contraction.
8. If treated surgically, what operation is indicated?
 - (a) Gastro-enterostomy.
 - (b) V-excision.
 - (c) Sleeve resection.
 - (d) Partial or subtotal gastrectomy.
9. What is the result of medical treatment?
 - (a) Mortality.
 - (b) Morbidity.
10. What is the result of surgical treatment?
 - (a) Mortality.
 - (b) Morbidity.

To be convinced that these problems present themselves in each ulcer case, one needs

only to sit in the consultation room and check this list. Rarely would any of these problems, except etiology and pathogenesis, escape discussion. Now let us apply roentgenology to a solution of them.

1. *Diagnosis.*—The negative or positive diagnosis of gastric ulcer rests almost exclusively upon the roentgenologic findings. Few are the surgeons who would operate on a chronic gastric ulcer without its presence having been established by roentgenologic findings.

1-A. *Differential Diagnosis.*—The differential diagnosis of cancer from ulcer is even a more difficult clinical problem than diagnosis. How can the x-ray help? If we combine all of our clinical and roentgenologic evidence of cancer and ulcer into a single group of evidence and say that it indicates an organic lesion (as is done in some of the larger clinics), the next question is, With what ease and degree of assurance can we separate these malignant and non-malignant lesions from each other solely by an observation of the roentgenologic findings? For example, if we were to take 56 cases of such organic lesions of the stomach, cancer and ulcer combined, and shuffle the charts, and single characteristic films from each serial set of roentgenograms, as one would shuffle a pack of cards, any one of you, or all of you, can pick the cancers from the ulcers by the roentgenograms as readily and as rapidly as one can separate the reds from the blacks in a pack of cards. In each new pack of cards there is a joker, an advertising card, and two blanks which may subsequently be used either as reds or blacks. So with the 56 cases, the proportion of jokers and blanks is almost exactly the same. Over and over again, I have watched medical students pick the malignant from the non-malignant lesion by this procedure and I know whereof I speak. You may ask, "How about the 8 per cent of jokers and blank cards?" A subsequent roentgeno-

graphic examination after the patient has rested in bed two weeks will decide whether the two blanks are to be red or black—ulcer or cancer. The joker will remain a joker until the bitter end, defying the clinician, the surgeon, the roentgenologist and, particularly, the pathologist, even when he has the gross and microscopic specimens in hand. Only by death or continued life is the status of the joker settled. This is no jest or joke—I have absolute proof of this group of cases which will be the subject of our next communication.

2. *Treatment.*—Should it be medical or surgical? Clinicians and surgeons will argue this point on *generalities* until "kingdom come," but in *specific cases*, observed roentgenographically, this problem is easy. What medical man would wish to treat such a case as this medically?² Or what present-day surgeon would wish to operate on an ulcer as small as this?² Although, as a matter of fact, in the dark days of ignorance, this particular ulcer was treated surgically. Between these extremes there are a great many medium sized ulcers, such as this.² The question arises, Which of these medium sized ulcers should be treated medically, and which surgically? This problem will be answered later in this paper under the heading, "The Results of Medical and Surgical Treatment as Observed Roentgenographically."

3. *Malignancy of Gastric Ulcer.*—Do benign gastric ulcers frequently become malignant? Clinical histories *can* be interpreted in such a way as to indicate that ulcers do become malignant, but the roentgenologic evidence indicates that benign gastric ulcers do not become malignant. That some ulcerating lesions may have malignant invasion in one or more areas of the surrounding mucosa, there can be no doubt, but we believe these were malignant from the

²Slides were shown demonstrating different types of gastric ulcer.

start. The frequency of this particular type of lesion compared with the benign type of gastric ulcer, on one hand, and the ordinary types of carcinoma, on the other, is relatively slight. Such malignant ulcers do not diminish in size in two weeks on rest in bed, and benign gastric ulcers, regardless of their size, *will reduce* very materially, usually to one-half their original size, in two weeks if the patient is kept in bed. Thus one can readily establish the differential diagnosis between these ulcers with a malignant lip and the benign gastric ulcer, by the very simple procedure of keeping the patient in bed for a period of two weeks, and making a second roentgen examination at the end of this time.

4. *Etiology:*

(a) Why does the ulcer develop where it does? The fact that ulcers develop on the ventral and dorsal surface of the stomach close to the lesser curvature is proven by roentgenograms of, approximately, 350 cases. A line drawing of the stomach, with a dot indicating the location of these ulcers, graphically attracts one's attention to their peculiar distribution. Here, for the first time, the roentgenologist may be required to go out of his field of activity for an answer to the problem. The question now presents itself, Shall he, by personal investigation of either literature or specimens, look to see what anatomical structures correspond with this peculiar distribution of the gastric ulcers? As a medical photographer, he does not claim this right, but as a physician, his field is not necessarily limited to the making and interpretation of roentgenograms. As precedent for extending his activity from one field of research to another in search for the truth concerning these problems, my worthy predecessor offers the most glorious example. From the roentgenographic examination of a bone lesion of the upper end of the humerus I was unable to make a positive diagnosis between infec-

tion and malignancy, although I leaned toward the infectious side. Surgery was performed by Dr. R. P. Wadhams and both the microscopic sections and roentgenograms were submitted to Dr. Ewing.

From Ewing's study of the microscopic slides, as a pathologist, he considered the lesion malignant. From his observation of the x-ray findings, he considered it non-malignant. Which of these did he choose to make his final diagnosis of malignancy or non-malignancy? He chose the x-ray findings—and the x-ray findings as *he* interpreted them. I would rather have *his opinion* of the x-ray findings as to the malignancy of this lesion than the opinion of nine-tenths of the roentgenologists. In fact, I think I would rather have his opinion, based on the roentgenologic findings, than the opinion of any roentgenologist of whom I know. If, by *his* intensive study of *roentgenograms* of bone lesions, he has strayed from the field of pathology and broken down the fence which separates his pastures from ours, *why may not* some of us stray into the pastures of pathology, and do so without either him or his colleagues feeling that we are trespassing? Personally, I have found the grazing in these adjacent pastures of pathology and anatomy most gratifying. If anatomists or pathologists have *not* noted the coincidence of the anatomical relation of the terminal branches of the left gastric artery to that of the most frequent location of corporic ulcers, or if this finding has been observed but buried in the archives of pathology, a reiteration of this finding by a roentgenologist may not be amiss.

(b) Why does the ulcer develop when it does? This is the only phase of the ulcer problem in which I am uncertain of the facts. When these facts are presented, as they will be in the study of pathogenesis and the process of repair, others instinctively jump to a certain conclusion, which I too

have formed. I am unwilling, however, to present this conclusion, lest it weaken the other portions of the article, for which ample proof is submitted.

5. *Pathogenesis*.—How does the gastric ulcer develop? Can the x-ray help us here? That gastric ulcers *develop* as *small* mucosal ulcers and *gradually* increase in size, by the acid gastric secretion gradually eating or digesting away that portion of the gastric wall that is unprotected by the mucosa in a manner specifically described by Aschoff, is so firmly established in the minds of clinicians and surgeons that few are cognizant of any other conception of the development of gastric ulcer. Yet, roentgenographically, the evidence is overwhelmingly in favor of some other manner of development of benign gastric ulcer. In proof of this, we submit the fact that many mucosal ulcers have been recognized roentgenographically and have been followed by subsequent examinations, and never have we observed a small mucosal ulcer that has subsequently become a large "true ulcer." Furthermore, we have never seen a truly benign gastric ulcer which, at a subsequent examination, was seen to be larger than it was at first. If ulcers do not develop in the orthodox way, is there any roentgenologic evidence to indicate how they do develop? A few cases have been observed roentgenographically during the early stage of pathogenesis and these have been seen to yield peculiar roentgenological findings. The crater, instead of being clear-cut and well-defined, as it usually appears, is deep and irregular as if the barium were mixed with some strands of non-opaque substance. Roentgenograms made of this case at a later date showed the conventional clear-cut crater usually observed in gastric ulcers. The ragged, irregular crater shown in the first roentgenogram was similar to the crater of a boil before the core had been extruded, and in the later stage after the core is out the crater has the conventional appearance. This finding has

been observed in several cases and leads to the conception of the gastric ulcer beginning as a boil. That is, the lesion begins as a necrotic area somewhere within the gastric wall and the exact location of the initial necrotic area predetermines the type of ulcer which will subsequently develop. Again may we stray into the green pastures of the pathologists through the rent in the fence already made by them and used by us, and search for the facts to confirm this conception of the pathogenesis of gastric ulcer? As an amateur pathologist without a knowledge of others' findings, and without the guidance of a professional pathologist, I have observed gross and microscopic findings confirming the roentgenologic findings as to the boil conception of the pathogenesis of gastric ulcer.

6. *Life History of Gastric Ulcer*.—How long does the gastric ulcer last and does it change in size or shape during its life history? Clinical symptoms suggestive of a gastric ulcer over a prolonged period of months, or even years, is considered one of the principal points of differentiation between ulcer and cancer by those who believe that ulcers do exist for a long period of time and cancers are usually of short duration. The gross and microscopic pathologic findings would seem, on superficial observation, to confirm this theory of long duration, but we believe that we have pathologic evidence to disprove this. These findings and conclusions will be described later under the heading "Process of Repair." Again we will revert to the roentgenologic findings to see if they help in determining the length of time that an ulcer lasts and if, under roentgenologic observation, it is observed to heal. Also, What is the process of repair by which the crater diminishes in size? Single roentgenologic examinations of gastric ulcers made during the life history of an ulcer reveal that the craters of gastric ulcers vary in size and shape. Early in our study of this subject, we classified ulcers accord-

ing to the size and shape of the crater and these were named because of the similarity of the crater to some object that they resembled. Thus, we had the large, indurated, or "palm-like" ulcer, the "letter-box ulcer" of Moynihan, because it had a constricted neck, or if it was small it was called the "collar-button ulcer"; others were designated as the "delaminating ulcer," or the small, round, or "punched-out" ulcers. These ulcers of various size and shape were originally considered as totally different types of ulcers, but, by repeated roentgenologic examinations, three or four days apart, we found that they were not different types or kinds of ulcers but simply different stages in the life history of the same ulcer. That is, a large, indurated, or "palm-like," ulcer soon contracts at the neck and becomes a "letter-box ulcer" and as it diminishes in size it becomes the "collar-button ulcer." It finally diminishes to a small, round ulcer. Other ulcers start as small, round ulcers and never go through the previous types of repair. By repeated examinations of ulcers every three or four days, we have come to know the life history of these ulcers; that is, whether they last for months or years, or whether they disappear in a short period of time. Even ulcers that are much larger than the proverbial quarter will habitually heal in about a month. Thus, we have established that the ordinary variety of benign gastric ulcer is short-lived, not much longer in duration than a boil or carbuncle on one's neck.

So much for the life history: Now the question arises, How does it heal? This problem of repair has had very little consideration but, from the roentgenologic findings, it is evident that gastric ulcers heal in two distinctly different ways. These will now be considered under the heading "Process of Repair."

7. *Process of Repair.*—The crater of a benign ulcer is gradually diminished in depth and diameter and, secondly, by an annular

constriction just beneath the mucosa which causes it to have a constricted neck, causing the "letter-box," "lagoon," or "collar-button" appearance. These findings were observed by repeated serial roentgen examinations. We will again stray into the pathological pastures in search of microscopic evidence bearing on the process of repair. If one searches a microscopic slide for something other than to determine whether or not the ulcer is malignant, he will find a most interesting field of investigation. Such an investigation reveals specifically the two processes of repair which were observed roentgenographically, namely, the filling of the crater from the bottom with newly formed fibrous tissue of various ages and, secondly, its diminution in size, particularly, just beneath the mucosa, by a cicatricial constriction of a deposit of connective tissue in the submucosa. This constrictive ring of connective tissue is like a cruller or quoit with a hole in the center around which the connective tissue readily contracts. Thus, the ulcer is diminished in size, first, by a growth of granulation tissue in the bed of the ulcer, and, secondly, by cicatricial contraction of the connective tissue surrounding it—both of these processes going on at the same time. The life history of the gastric ulcer is principally influenced by rest in bed, which relieves the torsion on the terminal branches of the left gastric artery. The fact that the average time required for an ulcer cure, or complete healing of the crater, is less than a month has been such a surprise to many clinicians that they have suspected that perhaps the roentgen examination had something to do with it. It is true that these patients had from twelve to eighteen roentgenograms made every three or four days and that the barium might have exaggerated the effect of the radiation by causing secondary radiation, but we have no proof or disproof of this contention. My own opinion is that roentgen rays may tend to prevent superficial

mucosal ulcers by diminishing or destroying the increased lymph follicles which are observed in the mucosa in all of these cases of small mucosal ulcers, and, in addition to this, they may have something to do with the process of repair. We know that boils on the neck are aborted or hastened in repair by x-ray treatment and, in my opinion, an ulcer of the stomach is nothing but a boil of the stomach. We believe that rest in bed causes a diminished tug on the terminal branches of the left gastric artery, thus increasing the blood supply so that it is greater when the patient is in bed than when he is in the erect posture. In one case in which a patient was undergoing bed treatment for gastric ulcer, he signed himself out at the end of two weeks at a time when the ulcer had become diminished to about one-half its original size. He remained up and about during the next month without rest in bed and the ulcer did not diminish in size during this time. He then returned to the hospital and, on bed treatment, it completed its cure in another two weeks. We believe that the rest in bed is a factor of paramount importance in the treatment of gastric ulcers, particularly those that occur near the incisura angularis.

8. *If treated surgically, what operation is indicated?* Four operations are available: (a) gastro-enterostomy; (b) V-excision; (c) sleeve resection; (d) partial or subtotal gastrectomy. Can the roentgenological evidence aid us in determining which of these particular operations is the best suited for the particular case under consideration? Individual surgeons habitually come to use one or the other of these procedures for most of the cases which present themselves for operation, regardless of the location or characteristics of the ulcer. Nevertheless, if practically all benign gastric ulcers will heal on medical treatment (rest in bed), why consider the type of surgical treatment which is necessary, except in the few cases in which there is extreme gastric

deformity or pyloric stenosis caused by a slipping or wadding of the mucosa so that it obstructs the pyloric canal and demands surgical relief? In such cases the roentgenologic findings are of great value in determining the type of operation that is best suited for the particular case under consideration.

9. *What is the result of medical treatment of gastric ulcer? Can the x-ray help in determining this?*

(a) *Mortality of Gastric Ulcer.*—Of all the patients with benign gastric ulcer treated medically, I am unaware of a single one who has died while under treatment. One patient, having an unusual pathologic type of ulcer with a most unusual clinical history, suffered from repeated hemorrhage and might have died under medical treatment had an operation not been performed. He did die after a simple jejunostomy. Actually, in our experience, there has been a zero mortality for medical treatment.

(b) *Morbidity(?)*—Morbidity is divided into two problems: Does the ulcer heal and remain healed or does it recur or do other ulcers form? Almost without exception, benign gastric ulcers, regardless of their size, heal in about three or four weeks if the patient is put to bed. In a limited number of cases symptoms recur, but in most of these cases if a subsequent ulcer is observed, it is located in some other region of the stomach; that is, if the first one is in the corpus, the second one will be in the pylorus, or *vice versa*, or one will be on the ventral and the other on the dorsal surface or, in some cases, they may be separated by only a centimeter or so. Very rarely another will occur so close to the original site that it may be considered a recurrence of the same ulcer. Again, the gastric ulcer is like a crop of boils on one's neck. A second or third boil is not considered a recurrence of the same boil, but a new boil; so with the ulcers. Some patients are susceptible to

ulcers and develop new ones which have a normal life history of three, four, or five weeks.

10. *Results of Surgical Treatment.*

(a) *Mortality.*—The mortality for gastric resections for corporic ulcers in my own personal experience, with good surgeons, runs about 50 per cent. With V-resections or sleeve resections it is only slightly less, and for gastro-enterostomy without excision or cautery and purse-string closure the mortality is considerably less, but the ulcer is not removed.

(b) *Morbidity.*—Morbidity with all its complicating factors, incomplete relief of symptoms, marginal ulcers and the inefficient follow-up histories, especially when these are made by the surgeon who performed the operation, are such that I do not wish to discuss the morbidity of gastric ulcers treated surgically, but if practically all benign gastric ulcers heal under medical treatment, why should we discuss the mortality or morbidity of surgical treatment? It is only in those few cases which are habitual ulcer-bearers that surgery might be considered, but, even in the case of these patients who do develop crops of gastric ulcers, I would most emphatically warn you to beware of subsequent jejunal ulcers after a gastro-enterostomy or even after a pylorotomy. We believe that roentgenology is the final acid test to be applied to all gastric ulcer cases to determine the results of either medical or surgical treatment and the relative value of each.

Now as to the scope of the activity of the roentgenologic physician—if he chooses to limit his activity to the making of roentgenologic examinations, either fluoroscopic or roentgenographic, and of simply reporting his findings as filling defects, irregularities, etc., making a definite diagnosis of cancer or ulcer in, say, half of the cases, and merely giving his impression in the other half, he selects the simple, safe, sane, and

easy way to practise roentgenology. But if he follows such a procedure, he becomes only a "good medical photographer," with no more responsibility than a medical photographer or technician often assumes, and, if so, he must suffer the consequences. On the other hand, if one learns to apply roentgenologic findings to all the problems of medicine, as we have shown they can be applied to the complicated, complex problems of gastric ulcer, then he may become of such value to the institution or community he serves that he no longer need worry concerning the much discussed subject of the status of the roentgenologist, at least, so far as he personally is concerned. A very serious problem, however, is the manner in which he seeks to apply these roentgenologic findings in his institution or community. This may be done diplomatically or antagonistically. Regardless of how I do it personally, I believe that it should be done diplomatically. When a doctor comes to see a series of roentgenograms of an ulcer case he has sent you, show him a similar case that has healed under medical treatment. If he doubts the single case, show him another. This, apparently, may not have any effect upon him, but as he thinks over it during the next week, he will wonder if he had better not try medical treatment, and, if he carries it out correctly, it will succeed. He then will think that he has discovered that gastric ulcers will get well under medical treatment, and he may write an article on it, completely forgetting where he got the idea—but never mind that. A few ulcers will not get well in two or three weeks. Most of these are malignant or are caused by some unusual pathologic ulcerative lesion, worthy of reporting with roentgenologic and pathologic findings. The infrequency with which an ulcer which has the roentgenologic findings of a benign gastric ulcer subsequently becomes malignant, is so far below the mortality which would result from an operation of sufficient severity to even hope for a cure

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were the ulcer malignant, that this factor should not be considered; at least, it should not be used as a crowbar to pry the patient onto the surgical table.

The problems of etiology, pathogenesis, pathology, life history of the ulcer, and the process of repair are problems which will interest only those who have a scientific bent. The roentgenologist can influence the surgeon to use some operation particularly applicable to the individual case being studied by simply showing him the result of such a procedure on some previous similar case. The surgeon, too, may forget the source of his inspiration to try some new operation or, at least, some operation which was new to him, and he may soon use it as the subject of an article.

Surgical specimens are getting more and more scarce. I used to be able to get any number of specimens of gastric ulcers from various hospitals but, because of the fact that almost invariably sections of these specimens show that the ulcer was in the active stage of repair at the time it was removed, many of the surgeons who originally co-operated with me in collecting this material

have ceased to operate on ulcers. Thus, in many instances, we have killed the goose that laid the golden egg of freshly removed surgical specimens and now the source of surgical specimens of gastric ulcer is largely limited to one or two hospitals well known in our community.

In order to judge all these factors for oneself, one must be more than a medical photographer. You must follow the case to the operating table or to the morgue; you must study the gross and microscopic specimens to see how they compare with the previous roentgenologic findings; you must follow the clinical and, particularly, the roentgenologic results of both medical and surgical cases and, very often, you must do this without compensation. However, by so doing, you will come to know for yourselves the facts just presented and, by diplomatically presenting these facts to your medical and surgical associates, you will gradually become of such value to your institution and to your community and to your colleagues, that the status of the roentgenologist, particularly insofar as you are concerned, will cease to be a problem.

EXPERIENCE IN IRRADIATING ALL TYPES OF BONE TUMORS¹

By MAX KAHN, M.D., BALTIMORE, MARYLAND

FOR the purpose of x-radiation of bone tumors, it has been found convenient to divide the tumors into two main groups, the benign and malignant. These again can be subdivided into the radiosensitive, partly radiosensitive, and non-radiosensitive.

The giant-cell tumor is commonly benign and frequently radiosensitive. A number of cases cured by irradiation alone have been reported in the literature. This giant-cell tumor is not the typical giant-cell tumor, but

the variant type, namely a bone cyst, containing giant cells which occur in the shaft side in young persons. A reaction follows soon after a course of irradiation, manifested by swelling of the surrounding soft structures, with more or less temporary increased distention of the tumor itself. This may continue for from three to six weeks, when there is a gradual diminution of the swelling of the soft structures and the tumor undergoes considerable regression. About this time there may be beginning evidence of calcification, slight at first, but with a gradual and definite increase in a few months.

¹Read before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

The expansion by then may have very largely undergone regression and the tumor tissue may be replaced with a varying degree of new, dense bone. The giant-cell tumor lends itself well to x-radiation. It is noteworthy in that it is both benign and radiosensitive and that cures may be obtained from irradiation alone, particularly in the long bones. In the small bones, such as the patella or the os calcis, failure is more common, although in some of these, cures have also been reported.

Typical bone cysts, which also come within the benign group, are not radiosensitive. These tumors, irradiation of which apparently produces very little or no change, are either best left alone or treated surgically. On the other hand, the acute bone cyst (variant type of giant-cell tumor), as noted above, is radiosensitive and yields to irradiation.

Exostosis, another benign tumor, is non-radiosensitive, since it is highly differentiated and contains a large element of osseous substance. Attempts to produce regression or absorption have proven ineffectual.

Chondromas, which are benign, are partly radiosensitive. Irradiation slows the growth when they are situated in the large bones, particularly in the sternum. One case of this kind, which has been under my observation and treatment for eight-and-a-half years, is reported in this paper (Case 2).

Of the malignant tumors, Ewing's sarcoma and chondroblastic sarcoma are radiosensitive. Because these tumors sometimes regress rapidly, the patient may remain symptom-free for from a few months to a few years. His condition during this time generally is improved until recurrence takes place, when degeneration occurs rapidly. Frequently there is metastasis to the lungs.

Secondary chondromyxosarcoma is partly radiosensitive and irradiation should be pushed, if resection or local operation is performed. Metastatic carcinoma is also partly radiosensitive and should always be irradi-

ated. The best results are obtained in cases in which the metastases are multiple rather than single, particularly from carcinoma of the breast. Multiple metastases from hypernephroma do not yield as well. These patients may sometimes live for four or five years in relative comfort. In multiple myeloma, irradiation is of value particularly as a palliative measure, although in some cases regression, and partial recalcification, has been obtained.

In the non-radiosensitive group, sarcoma of bone, such as the extremely undifferentiated type of osteolysis and chondromyxoma, are not benefited by irradiation; they are usually fatal despite any treatment. Included in this group is also the highly differentiated sclerosing sarcoma, which is resistant to irradiation.

This study brings up the subject of the best method of treatment of bone tumors, whether it is by irradiation alone, or by surgery, or by a combination of both. It is quite obvious that surgery is the method of choice in those malignant tumors in which amputation is definitely indicated. Irradiation should be given shortly after the amputation, the former being continued for a long time. On the other hand, if the malignant tumor is large and inaccessible, or difficult of surgical removal, irradiation should be resorted to and pushed to the limit. Sometimes, in a case of this kind, regression will occur, or the growth will be arrested, and months or years added to the patient's life; or an otherwise inoperable growth will be made operable. In the bone tumors discovered early roentgenographically, the best plan of treatment is to start irradiation as soon as possible. No harm will be done in giving the treatment while one is waiting to obtain a correct diagnosis. The diagnosis may not always be exact, if no biopsy is done. It will then have to be based on the roentgenographic evidence, clinical history, physical examination, and other laboratory tests. Indeed, a number of cases have been

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¹Read before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

amination of the lungs revealed moderate fibrosis, with a little peribronchial thickening, and several calcified shadows in the right and left hilus and in the lung fields. There was no positive evidence of metastasis.

For about a year, the patient received, at intervals of two and one-half months, deep x-ray therapy directed over the left shoulder girdle through different portals of entry. Roentgenograms of the chest from time to time revealed the restoration of the body of the scapula, coracoid process, and, to a lesser degree, the glenoid cavity. The swelling and infiltration of the soft structures completely disappeared. No marked changes of the lung structures were noted in the several roentgenograms.

In September, 1925, there was a small inflammatory area on the arm a little below the axilla, which had the appearance of a red indurated area, resembling infection. When it ruptured and discharged a small amount of purulent material, a little of the exposed tissue was removed. Dr. Bloodgood's note on the microscopic study was, "We are dealing with granulation tissue, very vascular. No evidence of sarcoma. This indicates that it had nothing to do with the disease, but is probably an accidental infection."

The patient, who has been under observation for nearly nine years, is examined about once a year, and was last seen in July, 1931. At that time, the x-ray examination of the chest and scapulæ revealed a completely restored left scapula. Clinically, the patient is well, enjoys life, and is able to work.

This case is of especial interest because, clinically, the lesion was thought to be inoperable and we believed that we were dealing with sarcoma involving the scapula, with infiltration of the surrounding soft structures. No microscopic diagnosis can be offered, but the result has been excellent

and the patient is well of an apparently malignant tumor.

Case 2. F. S., white, male, age 39 years, married. The patient stated that, when wrestling 11 years before the present exam-



Fig. 3. Case 3. Destruction of the ischium, in all probability due to sarcoma arising in an osteochondroma before deep irradiation.

ination, he was squeezed against the head of his opponent. He remained in bed for a few weeks at that time. About a year later he noticed a bulging about the size of a thumb in the region of the sternum. Two years after, the lump on the sternum gradually enlarged, increasing to the present size.

The patient, who was first seen in March, 1923, has been under observation since. He received the first course of deep therapy over the sternum on March 20, 1923, and has had up to the present time [1930], deep irradiation at intervals varying from two and one-half months to four years.

The first x-ray film revealed a tumor of the sternum, which we believed to be chondroma. Since then it has grown larger very slowly and there is now an increase in calcification. The lungs are essentially negative. The heart has been enlarged from



Fig 1 (above) Case 1 Extensive destruction of the scapula suggesting a malignant bone tumor, with infiltration of neighboring soft structures. Head of humerus dislocated upward.

Fig 2 (below) Case 1 Eight years after deep irradiation. Note re-formation of scapula, with areas of absorption in region of glenoid. Head remains dislocated upward but there is good function. Patient is clinically well. Practically no change has been noted in the bony structures in the last three years.

surgery in certain types of bone tumors; but we also feel that, in inexperienced hands, radiation therapy is best not employed. It is necessary, therefore, to decide which method is the proper treatment, irradiation, or surgery, or both. The selection of the correct treatment requires, in addition to the clinical history, physical examination, and laboratory tests, a knowledge of pathology and—most important—experience in the x-ray diagnosis of bone tumors.

CASE REPORTS

Case 1. C. McQ., age 16 years, was first seen by Dr. Bloodgood and the essayist on Jan. 25, 1923. He complained of pain in the left scapula and inability to move the shoulder joint easily. He remembered having fallen on the shoulder about five months earlier. There was a swelling which had been present since then. There was no marked pain, only tenderness. Examination showed the left shoulder lower than the right, the left wing scapula not being seen. The most marked swelling was toward the arm, below the spine. On palpation, swelling, which felt like edema, was noted, chiefly over the portion of scapula below the spine. Below the spine there was marked infiltration of the soft parts. There was suggestion of fluid in the joint.

A number of x-ray examinations were made during the first year, before and after irradiation. A review of the several roentgenograms of the chest and left scapula made from Jan. 31, 1923, to Jan. 23, 1924, reveals the following. There was marked destruction of the left scapula, chiefly in the region of the glenoid cavity and coracoid process and body. The spine of the scapula and acromion process appeared intact. The head of the left humerus and shaft revealed bone atrophy. The head was displaced upward so that it was out of the glenoid cavity. There was considerable swelling and infiltration of the soft structures surrounding the left shoulder girdle. Roentgen ex-

irradiated with splendid results, without resorting to biopsy. We feel that, if the patients are treated by an experienced roentgenologist, irradiation has advantages over

with a sclerosing periostitis and not sarcoma.

The case has been followed from time to time. In the last report received (April 30, 1931), the lesion is said to be entirely healed and the patient clinically well.

Case 5. Mrs. S. F., age 30 years, was first seen March 1, 1926, when she appeared with a lump in her left breast. Operation was advised, but refused. She went to New York, where the complete operation for cancer was done in August, 1926. The patient returned for deep irradiation, the first course of treatments being administered over the chest in September, 1926. During the following three years, she returned at

intervals of from three to six months for further irradiation. Meanwhile, numerous roentgen examinations were made of her chest and skeleton. She received several blood transfusions because at times her hemoglobin and red blood cells were low.

The x-ray films of the chest and skeleton were negative until January, 1928, when suspicious metastatic shadows were found in the right mediastinum. A little later, metastatic shadows were found in the vertebræ, pelvis, and other bones. Her pain was invariably stopped by irradiation so that opiates could be discarded. The patient lived for about three years in relative comfort.

A REPORT OF OVER A THOUSAND UNSELECTED CANCER CASES, TREATED IN 1931-1932, AT THE NEW YORK CITY CANCER INSTITUTE, WELFARE ISLAND¹

By IRA I. KAPLAN, B.Sc., M.D., Director, Division of Cancer, Department of Hospitals,
NEW YORK CITY

GENERALLY speaking, the aim of therapeutic efforts in medicine is to produce specifically beneficial results. No matter what the disease, the physician is expected to forestall death and prolong life in comfort. The sole exception seems to be in the case of cancer, and here the public has, unfortunately, been led to believe that from the inception of the disease the patient is doomed, so that not infrequently is the physician requested to do what he can to bring on the inevitable result as painlessly as may be.

What is it that has created this impression in the public mind? No doubt the most important factor has been the failure to identify a definite cause of cancer. The mystery of the unknown has served to add an altogether unnecessary dread to the disease.

Due to its insidious growth and the absence of pain in its early stage, most of its victims seek treatment long after the disease has progressed beyond the local area. It is because patients apply for medical assistance late in the disease that their chance for cure is so slight; as a corollary to this inability to offer a cure many cases drift into the clutches of quacks.

As yet no specific remedy has been found for cancer and we have had to confine our methods of treatment to surgery and radiation, which remedies have resulted in at least a moderate number of cures.

The vast number of variations of cancer manifestation has prevented a definite standardization of therapy, whether by surgery or irradiation. While we have progressed considerably in our knowledge of the management of cancer cases, we have not as yet been able to prescribe any particular type of treatment as a curative agent for all condi-

¹Read before the Radiological Society of North America, at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28 Dec. 1, 1932.

From the Department of Hospitals, Dr. J. G. William Greff, Commissioner.



Fig. 4. Case 3. The pelvis reveals recalcification of the ischium five years after deep irradiation.

the first time the patient came under observation.

There has been no surgical intervention; the only treatment has been deep irradiation. The patient is at present clinically well and is able to attend to his work as salesman. It may be of interest to note that his son, F. S., Jr., age 17, a student, has a chondroma of the middle phalanx of the left index finger, suggesting inheritability of this tumor.

Case 3. Mrs. A. G. S., white, age 30 years, had indefinite symptoms in the region of the right hip and thigh for one year or more preceding this examination. There had been a stiffness in that region for three months and an occasional limping for six months. One month previously, she had noticed a lump in the region of the right groin. The patient was showing definite loss of weight when she was first seen.

The general physical examination was negative. There was a round, smooth mass beginning at the pelvis and extending down the right thigh for four inches, seemingly anterior to the adductor muscles. The mass seemed to be arising from the ischium. X-ray examination showed a fairly trans-

parent, trabeculated tumor in the adductor region attached to the pelvis, with definite destruction of the ischium. X-ray examination of the chest was negative and operation was not advised. Deep x-ray therapy was given to the pelvis from March 16, 1923, to a few months before the patient's death in February, 1928.

The patient died five years after the date of examination and six years after the onset of symptoms. The exact cause of death is not known, but the family physician reported it as hemorrhage. No tissue was obtained for examination. Judging from the clinical history and the x-ray studies, this is undoubtedly a case of sarcoma arising secondarily in a benign osteochondroma of the pelvis. Unfortunately, no microscopic proof of the diagnosis is available.

Case 4. W. M. O., Jr., age 18 years, sustained trauma to the thigh in November, 1923, in a football game. At first there was only a slight limp, but two weeks later the patient began to complain of an ache, which was worse at night. There was no swelling. Treatment by an osteopath three weeks after the injury was followed by some swelling.

On palpation during physical examination one month after the injury, one felt at the junction of the upper and middle third of the thigh a mass, most marked on the outside, which resembled bone. X-ray examination revealed an area of destruction of cortical bone under an area of new bone formation. The question of sarcoma was raised. The chest was negative. Dr. Bloodgood stated that he had never cured a case of sarcoma above the middle third of the femur and advised deep x-radiation. The patient was given a course of deep irradiation in January, 1924, and another in March. Some months later there was spontaneous opening, with discharge of clear fluid and a sequestrum. The final impression was that we were probably dealing



Fig. 3. Epithelioma of upper lip; insufficient radium therapy. Recurrence, with metastasis to neck glands.

the late reactions or sequelæ of harmful effect, may not appear until many months after treatment has been given.

A full knowledge of the early and late reactions is essential, therefore, in the training of one who would carry on successful cancer therapy. This is possible only if patients can be cared for under proper auspices in an institution specially designed and equipped for such work. The Cancer Hospital on Welfare Island, under the jurisdiction of the Division of Cancer of the Department of Hospitals, City of New York, is an institution of this type. To this hospital come patients from all sections of the city. They are accepted regardless of race, creed, color, or economic status, and whether or not they have previously received treatment elsewhere, either from private physicians or hospitals or from hospitals of the municipal system. In this cancer hospital patients are received in every condition, from the incipient stage of the disease to the most advanced. Old and young, all come to us for care, since cancer is no respecter of age. Here we can judge the results of treat-

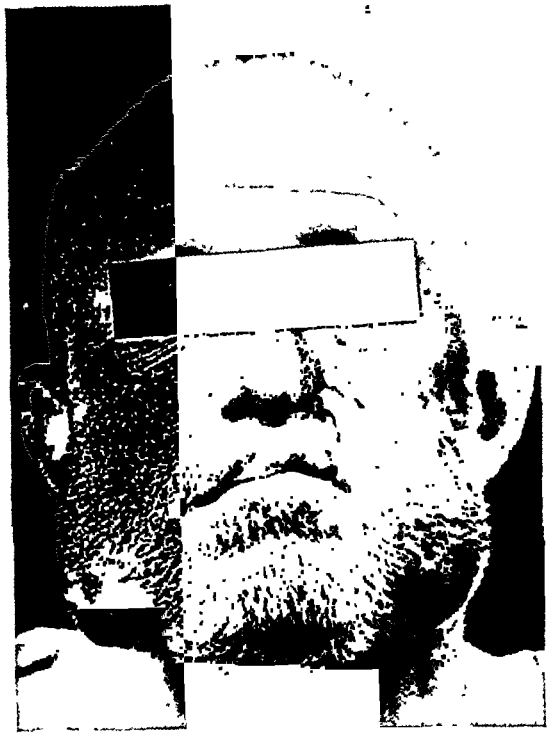


Fig. 4. Epithelioma of upper lip; insufficient radium therapy. Recurrence, with metastasis to neck glands. Post-radium therapy recurrence.

ment already given, whether by surgery or radiation, or a combination of both; and here we can see the progression of the disease throughout the body, even though the original, local lesion be entirely eradicated. Every type and method of treatment has been utilized in caring for these patients and much can be learned by a careful study of the work done here.

Pathology.—In most cases the pathology was ascertained either by direct biopsy or by information from referring hospitals. Of the 1,236 cases, 240 had had no treatment before coming to our hospital, and the balance (996) had been previously treated elsewhere, by surgery or irradiation or both. No less than 40 per cent of all cases admitted to the hospital received no treatment other than custodial care, owing to the advanced stage of their condition. Of all the cases admitted to the Cancer Hospital, 69 per cent were referred by 26 other hospitals and the rest by private physicians. Of the



Fig. 1. Epithelioma of lower lip treated by surgical excision and neck gland dissection. No irradiation. Recurrence several months later. Patient died.



Fig. 2. Epithelioma of lower lip treated by small dose of interstitial radium, followed by local resection. Recurrence. Patient still living.

tions. Many physicians, however, who are qualified neither by experience nor training, attempt cancer treatment along set lines, disregarding entirely the fact that a clinical understanding of the individual case is required in each instance.

The early enthusiasm that attended the advent of radiation as a new force in therapy of cancer was a source of no little harm in this field. Because in the beginning radiation from radium and x-rays was acclaimed as a universal panacea for cancer, legitimate physicians readily accepted this new form of therapy, while the quacks seized upon it as a heaven-sent, newer, get-rich-quick scheme.

Mistakes in surgery can fortunately be corrected in many instances, and life saved, but errors in radiation therapy rarely can be corrected, the condition in most cases becoming worse and more painful for the victim. Often results of such errors have been

so dreadful as even to justify the professional rejection of its employment.

What becomes of patients treated for cancer is a question asked not alone by the general public but by the profession as well. For if the doctor is to learn anything at all about cancer, he must know the results of his treatment of this disease. Only in this way can he avoid the repetition of possible errors, and, as errors in radiation technic often cause extensive destruction of tissue, mistakes in this field of therapy prove tremendously costly.

Not always, in radiation, are the results immediately apparent. By reason of radiation's latent powers, its effects often are delayed over a period of many weeks and the biological reaction may extend beyond the usual period of action and resemble results as seen following surgical procedures. The so-called "Spätschadigen" of the Germans,



Fig. 3. Epithelioma of upper lip; insufficient radium therapy. Recurrence, with metastasis to neck glands.



Fig. 4. Epithelioma of upper lip; insufficient radium therapy. Recurrence, with metastasis to neck glands. Post-radium therapy recurrence.

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latter class of patients, 25 per cent had to be conveyed from their homes, being bedridden or hopeless cases.

The following tabulations show the types of lesions received for treatment and some details of the more important conditions cared for.

List of Charts.—1, Total number of cases received and results, January 1, 1931, to September 30, 1932; 2, Mouth and Throat; 3, Gastro-intestinal Tract; 4, Breast Cases; 5, Gynecological Cases; 6, Genito-urinary Cases; 7, Epitheliomas; 8, Hodgkin's Disease; 9, Sarcomas; 10, Type of cases present in the hospital October 25, 1932.

CHART 1-A—A STUDY OF OVER A THOUSAND UNSELECTED CASES DURING JANUARY 1, 1931, TO SEPTEMBER 30, 1932

Patients in Cancer Hospital, January 1, 1931....	186
Patients received from January 1, 1931, to September 30, 1932.....	1,434
Primary admittances	1,236
Readmittances	384

Report on 1,236 Primary Cases

1,048 white	617 males
180 colored	619 females
5 yellow	101 years (oldest)
3 not stated	11 years (youngest)

Diagnosis

1,125 carcinomas
57 sarcomas
21 Hodgkin's disease
28 benign
5 no diagnosis

Results

294 discharged living	762 deaths
221 in the hospital	76 autopsies

Additional Data on 570 Patients of 1932

487 married	223 born in U. S. A.
72 single	347 foreign born
11 not stated	

CHART 1-B

	Total	Improved	Not Improved	Dead
<i>Epithelioma</i>				
Face	60	30	6	24
Scalp	3	0	1	2
Skin, various	3	0	0	3
Neck	3	0	1	2
<i>Metastatic</i>				
Origin unknown	9	0	5	4
<i>Primary Carcinoma</i>				
Lip	22	7	6	9
Mouth	32	2	5	25
Tongue	60	6	8	46
Palate	9	2	3	4
Tonsil	29	3	5	20
Pharynx	5	0	2	3
Orbit	1	0	0	1
Antrum	9	2	1	6
Larynx	28	2	7	19
Parotid	2	0	0	2
Bronchus	4	1	1	2
Lung	19	1	4	14

	Total	Improved	Not Improved	Dead
Thyroid	7	2	2	3
Neck	2	0	0	2
Breast	148	18	42	88
Esophagus	34	7	3	24
Stomach	108	5	23	80
Pancreas	2	0	0	2
Liver	3	0	0	3
Gall bladder.....	1	0	0	1
Cecum	6	1	2	3
Colon	7	1	2	4
Sigmoid	10	1	1	8
Rectum	104	20	22	62
Anus	2	0	0	2
Kidney	7	1	5	1
Bladder	28	2	5	21
Urethra	1	0	0	1
Ovary	42	8	9	25
Cervix	212	67	31	114
Uterus	11	4	0	7
Vagina	3	1	0	2
Vulva	5	1	1	3
Penis	12	1	1	10
Testicle	2	0	0	2
Teratoma	3	0	0	3
Scrotum	3	0	1	2
Prostate	50	6	9	35

<i>Metastatic</i>				
Primary unknown..	14	1	4	9
Sarcoma	57	2	19	36
Hodgkin's disease..	21	5	7	9
Benign tumors	33	14	8	11

CHART 2-A

<i>Lip Cases</i>	
Total number	22
Males	22
Females	0
White	21
Colored	1
Married	19
Single	3

Ages.—Youngest, 46 years; oldest, 69 years.
Four cases had had no previous treatment; 15 cases had metastases.

Results.—Improved, 7; unimproved, 6; dead, 9.

Comment.—Some of the most distressing conditions we have had to deal with were the malignancies of the lip. The upper lip was involved in one case only. The pathology in all cases was squamous-cell epithelioma. In seven cases glandular metastases were present. In four cases previous neck dissection, with removal of the local lip lesion, had been performed. In eight cases some type of radium therapy had previously been used unsuccessfully. In one case 57 radium applications had been given to a resistant local lesion. In several instances irradiation healed the local lesion, but failed to prevent extensive metastases. From our observation the cases treated by interstitial

radium therapy did not do as well as those treated by surface radium therapy. In some cases, if operative removal of the bulk of the tumor had been done, subsequent irradiation would have proven more successful.

CHART 2-B

<i>Mouth Cases</i>	
Total number	32
Males	32
Females	0
White	32
Colored	0
Married	31
Single	1
<i>Ages</i> —Youngest, 44 years, oldest, 80 years	
Twenty-three cases had metastases	
<i>Results</i> —Improved, 6; unimproved, 4, dead, 22	

Comments.—In most cases the local malignant lesion was associated with bad dental conditions and poor mouth hygiene. In some instances direct injury to the mucosa was easily traced to ragged, infected, filthy teeth. Without exception all these cases were males and all of the white race. The sites of involvement were the floor of the mouth, the alveolar ridge, and the buccal mucosa. In most instances extensive metastatic involvement of the regional lymph nodes was present, and in some, necrosis of bone had occurred. Bone destruction was, in our opinion, due to previous irradiation rather than to malignant extension. Associated syphilis was present in but two cases. Radiation failed in all but two cases. Radiation with surgery gave no successful results. Fifty per cent of the cases were admitted in an advanced condition. Death occurred in most instances from cachexia and starvation.

CHART 2-C

<i>Palate Cases</i>	
Total number	9
Males	9
Females	0
White	7
Colored	2
<i>Ages</i> —Youngest, 42 years, oldest, 69 years	
<i>Results</i> —Improved, 2, unimproved, 3, dead, 4	

Comments.—In our series, this condition affected males only. Most cases exhibited extensive ulcerative growths involving both the soft and hard palates. Surgical removal failed in cases so treated. Metastases were



Fig 5 Epithelioma of tongue, with extensive involvement of base of tongue, tonsil, and pharynx, with neck metastases. External irradiation only, progressive involvement. Death.

present in all instances. Only two cases improved with local interstitial irradiation.

CHART 2-D

<i>Tongue Cases</i>	
Total number	60
Males	59
Females	1
Married	51
Single	9
White	58
Colored	2

Ages—Youngest, 36 years, oldest, 101 years.

Fifty-two cases had had previous treatment, 8 cases were never treated.

Results—Improved, 6, unimproved, 8, dead, 46.

Comments.—All but seven cases were advanced and the local lesion was associated with bad mouth conditions in all cases. Only six cases had a concomitant syphilis. Metastases were present in all but six cases. The pathology in all cases was squamous-cell epithelioma. Twenty-eight cases had some sort of treatment previous to admission. In six cases surgical removal of the lesion had not hindered the disease. Ra-



Fig. 6. Carcinoma of antrum. Treatment consisted of surgery and radium therapy. Recurrence to neck two years later.

dium therapy employed in most cases was of the interstitial type. In all but six cases irradiation was unsuccessful. In several cases gastrostomy had to be performed for feeding purposes. Death ensued in most cases from cachexia, starvation, and pneumonia. In our opinion, the poor results from irradiation were due to inadequate treatment in the first instance and failure to provide proper mouth hygiene.

CHART 2-E

<i>Pharynx Cases</i>	
Total number	5
Male	4
Female	1
Married	5
Single	0
White	4
Colored	1
<i>Ages.</i> —Youngest, 22 years; oldest, 47 years.	
<i>Results.</i> —Improved, 0; unimproved, 2; dead, 3.	

Comments.—All our cases were advanced and hopeless. All had had previous treat-

ment of some sort for “nose trouble.” Extensive involvement of the pharynx and adjacent tissues precluded any but palliative therapy.

CHART 2-F

<i>Larynx Cases</i>	
Total number	28
Male	27
Female	1
Married	22
Single	5
White	25
Colored	3
<i>Ages.</i> —Youngest, 28 years; oldest, 80 years.	
<i>Results.</i> —Improved, 2; unimproved, 7; dead, 19.	

Comments.—All but one were males and all but three were in an advanced stage of the disease. Tracheotomy had been performed elsewhere in 15 cases, and four patients required emergency tracheotomy upon admission, one of whom died during operation. In all cases the lesion had extended beyond the larynx, and in 16 cases lymph node metastases in the neck were present. Only four cases had radium therapy, and seven cases had had x-ray therapy elsewhere previous to admission. Treatment at the hospital consisted of tracheotomy in instances in which it was necessary and high voltage x-rays to the neck when possible. Only two cases improved under treatment. Protracted x-ray therapy was not possible in any instance, and x-ray therapy of the regular type failed to check the progressive extension of the disease.

CHART 2-G

<i>Tonsil Cases</i>	
Total number	29
Male	25
Female	2
Not stated	2
White	25
Colored	3
Yellow	1
Married	20
Single	7
<i>Ages.</i> —Youngest, 33 years; oldest, 85 years.	
<i>Results.</i> —Improved, 2; unimproved, 5; dead, 22.	

Comments.—Malignancy of the tonsil occurred in all but two cases in males of the 50-60 age group. Each tonsil was about equally involved, and involvement of both tonsils at the same time occurred in two cases. All patients but one were in an ad-

vanced stage of the disease. Only three cases had had tonsillectomy before admission. The pathology in most cases was squamous-cell epithelioma. All cases were treated with x-ray therapy and 10 had radium applications either interstitially or through a pack. In spite of treatment 22 patients died, of whom only one lived more than a year, the average duration of life of the others being but from two to three months. Only two cases were improved sufficiently to be discharged to their homes. In our opinion these cases were all referred too late for effective treatment. Intensive irradiation in an early stage might have given better results.

CHART 3-A

Esophagus Cases

Total number	34
Male	29
Female	5
Married	29
Single	5
White	31
Colored	3
<i>Ages</i> .—Youngest, 40 years; oldest, 74 years.	
Three had had previous treatment; 31 had had no treatment.	

Results.—Improved, 7; unimproved, 3; dead, 24.

Comments.—The esophagus cases represented some of the most pitiful received. In most instances the patients were cachectic, wasted, and dehydrated. Most cases were white, married males over 40 years of age. The most prominent symptoms in all cases were difficulty in swallowing and marked loss of weight. Only three cases had had more than palliative treatment before admission. Diagnosis was made in most cases by x-ray examination. Our study of these cases leads us to conclude that treatment was applied far too late in the course of the disease to produce good results. Favorable results followed only when gastrostomy was performed early and before complete dehydration had occurred. In most instances emergency gastrostomy resulted in rapid death of the patient. Treatment consisted of gastrostomy, forced feeding, and x-ray therapy through the mediastinum. Radium



Fig. 7. Epithelioma of tongue and floor of mouth, with neck gland involvement. Insufficient irradiation with gold radon seed implantation. Death.

therapy was attempted in a few instances, but the results were not encouraging.

CHART 3-B

Stomach Cases

Total number	108
Males	80
Females	28
Married	91
Single	17
White	89
Colored	17
Yellow	1
Not stated	1

Ages.—Youngest, 28 years; oldest, 80 years.

Fifty-eight cases in advanced stage; 28 cases had metastases; 5 cases were never treated.

Results.—Improved, 5; unimproved, 23; dead, 80. In 1932 there were 46 cases, as follows: 38 Gentiles; 8 Hebrews.

Comments.—Involvement of the stomach occurred third in frequency of all conditions treated. Males were affected about four times as often as females. The disease occurred most often in the 40-60 age group. Metastasis was already present upon admission in 50 per cent of the cases. Duration of symptoms varied from one month to ten years. X-ray diagnosis was positive in



Fig. 8. Carcinoma of rectum. Radical resection. No irradiation. Recurrence, with gluteal extension. Death.

nearly all cases. Some form of previous operation on the stomach had been done in 10 per cent. In several, previous gastro-enterostomy had been performed. In 20 per cent of the cases the condition was so hopeless that no scientific therapy of any kind could be given. In six cases radium therapy and in 20 cases x-ray therapy was administered. In most cases only supportive treatment and custodial care were possible. Operation was performed in 12 cases. Death occurred in most instances from the extension of the local lesion, with cachexia, starvation, and metastases to other organs.

Our study of these cases suggests that in cancer of the stomach early diagnosis and early radical operative procedure are essential to the lowering of the death rate. Irradiation so far in our hands has been of little avail.

CHART 3-C

<i>Rectum Cases</i>	104
Total number	59
Male	45
Female	71
Married	33
Single	98
White	6
Colored	



Fig. 9. Epithelioma of lower end of rectum. Local treatment for hemorrhoids. Extension metastasis to inguinal nodes. Death.

Ages—Youngest, 25 years; oldest, 90 years.

Results—Improved, 20; unimproved, 21; dead, 63.

In 1932, of the 41 cases, 26 were Gentiles and 15 Hebrews.

Comments.—This lesion was the fourth in frequency in our series, occurring slightly more often in males than in females. In 80 per cent of the cases some form of operative procedure had been performed previous to admittance to the Cancer Hospital, in most instances, merely a colostomy for emergency relief of obstruction. The pathology in most cases was adenocarcinoma and the site of the lesion in the lower portion of the rectum. Duration of symptoms to the time of admission varied from one week to five years. The most frequent symptom complained of was bloody stools, with diarrhea or constipation. Several patients had had previous treatment for hemorrhoids. Treatment after admittance to the Cancer Hospital in most instances was palliative only: colostomy in seven cases; radium therapy in 20 cases; beside specific therapy in 15 cases, several had x-ray therapy. In several cases previous destructive radical operations had been performed, with increased misery for the patients. Several had received some form of radium therapy before admission to the Cancer Hospital. In most instances



Fig 10 Extensive carcinoma of breast, no skeletal metastasis; too late for therapy



Fig 11 Carcinoma of breast Radical mastectomy Recurrence, en cuirasse type, six months later. No irradiation

these cases suffered intense pains from sloughing due to over-radiation, or secondary peritonitis from radiation necrosis or perforation. Radium treatment in most instances was by means of the proctostat (rectal applicator), which eliminates radium necrosis to a great extent and entirely prevents perforation necrosis and associated peritonitis. Death was due in most instances to cachexia and extension of the local lesion

CHART 4

<i>Breast Cases</i>	
Total number	148
Males	8
Females	140
White	119
Colored	29
Married	124
Single	24
Pregnancies	77

Age—Youngest, 22 years, oldest, 78 years

In 1932 there were 72 cases, as follows: Gentiles, 57, Jews, 15

Previous Treatment

57 had surgery
19 had surgery and x-rays
11 had radium
53 had x-ray
8 had no treatment
113 had metastases
11 in both breasts
67 right breast
67 left breast
3 not stated

Results—Improved, 18; unimproved, 42; dead, 88

Comments—In our study of these cases several factors were noted. Most cases occurred in females, and most often in those who had borne children. White women were more often afflicted than colored, and the right and left breasts were equally involved. Involvement of both breasts was uncommon. Jewish women were slightly less subject to this type of cancer than Gentiles. The most frequent age of involvement was in the 40-50 year group. The pathology in most instances was adenocarcinoma, next in frequency were the duct cell and scirrhous types.

A study of the methods of treatment showed that surgery was performed in 50 per cent of all cases but in only 25 per cent of these was post-operative x-ray therapy employed. The type of operation varied. In most instances a more or less radical operation was performed; in no instance was a simple mastectomy done. In 90 per cent of these cases death occurred from metastatic involvement, which was so extensive when the patient came to us, a short time after operation, that we were of the opinion



Fig. 12. *En cuirasse* carcinoma following radical mastectomy and post-operative x-ray therapy four years previously.

the metastases must have existed at the time of operation.

A distressing condition of many cases in which radical mastectomy had been performed, was swelling of the arm due in most instances to too extensive surgery. In the 30 per cent of cases with extensive skeletal metastases, only palliative treatment was possible. In many cases, radium and x-ray therapy was employed, but failed to arrest the disease in any instance. From our observations, cases treated with pre-operative irradiation and careful surgery gave the best results. Endothermic surgery was of value in ulcerated, bulky tumor growths, but added no additional assurance against development of metastasis.

CHART 5

Ovary Cases

Total number	42
White	34
Colored	8
Married	27
Single	15
Ages.—Oldest, 71 years; youngest, 25 years.	

In 1932 there were 23 cases, of which 17 were Gentiles and 6 were Hebrews.

Previous Treatment.—Twenty-four had been operated upon, and 23 had metastases.

Results.—Improved, 8; unimproved, 9; dead, 25.



Fig. 13. Carcinoma of breast. Recurrence and skeletal metastasis following radical surgical mastectomy.

Comments.—A study of the cases of ovarian malignancy showed that married women were affected twice as often as single ones, and the incidence among white women was five times that among colored. In most instances the duration of symptoms was 10 months; in one case it was 12 years (this patient improved under x-ray therapy and left the hospital after a stay of three months). In most cases the patients presented a palpable pelvic tumor, associated with ascites. Fifty per cent of the cases had had previous operation. Generalized metastasis was present in 5 per cent of the cases, involving the peritoneum and in a few cases the liver and lungs. Because in most instances the cases referred to the Cancer Hospital were in an advanced stage of the disease, treatment consisted in palliation

with x-rays and symptomatic surgery for the removal of accumulated ascitic fluid. The best results were achieved by x-ray therapy, operative removal of the bulk of the tumor, and additional x-ray therapy.

CHART 5-A

<i>Uterus Cases</i>	
Total number	11
White	9
Colored	2
Single	1
Married	10
Pregnancies	8
<i>Ages</i> .—Youngest, 40 years; oldest, 75 years.	
<i>Results</i> .—Improved, 4; dead, 7.	

Comments.—All but one case were married women but only eight of these had borne children. In two cases previous hysterectomy had been done for supposedly benign bleeding and the malignant diagnosis made post-operatively. Most cases were in the 50-60 year age group. Post-menopause bleeding was the most common complaint. Many of the cases were far advanced in the course of the disease, and in some only a diagnostic curettement with radium in the uterus for controlling the bleeding was the therapy used. High voltage x-rays through the pelvis controlled the bleeding in some cases. Metastasis in the pelvis was present in most instances; in one case the metastasis was in the lungs. In seven cases death approached progressively in spite of irradiation.

CHART 5-B

<i>Cervix Cases</i>	
Total number ..	212
White ..	149
Colored ..	63
Married ..	203
Single ..	6
Pregnancies ..	9
Not stated ..	54
<i>Ages</i> .—Youngest, 23 years; oldest, 80 years.	

Comments.—In no instance was an early case of cancer of the cervix received at the Cancer Hospital, while in most instances the condition was well advanced. The disease occurred mostly in white Gentile women, nearly all of whom were married and had



Fig. 14. Double radical mastectomy; one-year interval between operations. Post-operative x-ray therapy; metastasis to skull; blindness in one eye. Death.

borne children. In 16 cases a previous hysterectomy had been performed and malignancy developed in the post-operative stump of the cervix or cervico-vaginal wall. A concomitant syphilis was present in 20 per cent of the cases. Previous treatment given in all but 25 per cent of the cases was irradiation of one kind or other. The pathology in most instances was squamous-cell epithelioma, plexiform next, and adenocarcinoma only in 11 cases. Treatment at the Cancer Hospital consisted of intensive vaginal hygiene, transfusions in cases in which it was necessary, and irradiation by high voltage x-rays and radium. Surgery for relief of local infections was employed in few instances. Death was due in most cases to malignant extension to the pelvis, with associated infection.



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A distressing condition of many cases in which radical mastectomy had been performed, was swelling of the arm due in most instances to too extensive surgery. In the 30 per cent of cases with extensive skeletal metastases, only palliative treatment was possible. In many cases, radium and x-ray therapy was employed, but failed to arrest the disease in any instance. From our observations, cases treated with pre-operative irradiation and careful surgery gave the best results. Endothermic surgery was of value in ulcerated, bulky tumor growths, but added no additional assurance against development of metastasis.

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Ages—Oldest, 71 years; youngest, 25 years.

In 1932 there were 23 cases, of which 17 were Gentiles and 6 were Hebrews.

Previous Treatment.—Twenty-four had been operated upon, and 23 had metastases.

Results.—Improved, 8; unimproved, 9; dead, 25.



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Comments.—In no case of carcinoma of the penis was the Wassermann positive. In some cases dissection of the regional nodes was done. High voltage x-ray therapy was used in all cases and local radium applicators were employed in several. Only two patients survived, 10 rapidly succumbing to secondary infection and metastases.

CHART 7

<i>Epitheliomas</i>	
Total number	78
Distribution	
Face	69
Scalp	3
Skin (various)	3
Neck	3
Metastatic (origin unknown)	9
Males	50
Females	28
White	75
Colored	2
Yellow	1

Ages.—Youngest, 20 years; oldest, 85 years.

Results.—Improved, 30; unimproved, 13; dead, 35.

Comments.—Surface epithelioma occurred in most instances in the 50-70 years age group. The most frequent site of superficial epithelioma was on the face. Pathologically, the usual form was basal-celled. Frequently the lesion started as a small ulceration or keratotic wart. In two instances malignancy developed on an old lupus which had been persistently and frequently treated with x-rays. In spite of the seemingly mild malignancy of the basal-cell type of epithelioma, some of the most destructive lesions were in this group and persisted in spite of treatment by x-rays, radium, or surgery. In most instances the lesion had been over-irradiated. A study of this type of case suggested that the initial treatment failed because it was not intensive enough, and subsequent irradiations produced more and more necrosis, associated with radiation vaccination. In one case malignancy and ulceration followed excessive exposure to diagnostic x-rays. In another, the malignancy developed following excessive x-ray treatments of keloids on a severe burn. In most instances death followed extensive destruction of the skin and



Fig. 17. Epithelioma of scrotum, with metastasis. Progressive growth in spite of x-ray therapy. Death.

adjacent structures. The colored race is seldom affected by this type of lesion.

CHART 8

<i>Hodgkin's Disease</i>	
Total number	21
Male	17
Female	4
Married	19
Single	2
White	21
Colored	0

Ages.—Youngest, 26 years; oldest, 73 years.

Results.—Improved, 5; unimproved, 7; dead, 9.

Comments.—All cases were in an advanced condition of the disease, most of them having been admitted because of general weakness. Positive biopsy was had in every case. Most often the condition exhibited a generalized swelling of the lymph glands of the neck, axillæ, and inguinal areas. There were two cases of abdominal Hodgkin's. Several had associated enlargement of the spleen and mediastinal nodes along with generalized superficial adenopa-



Fig. 15. Carcinoma of prostate. Operation; recurrence; metastasis to pelvic bones and skin (proven by biopsy).

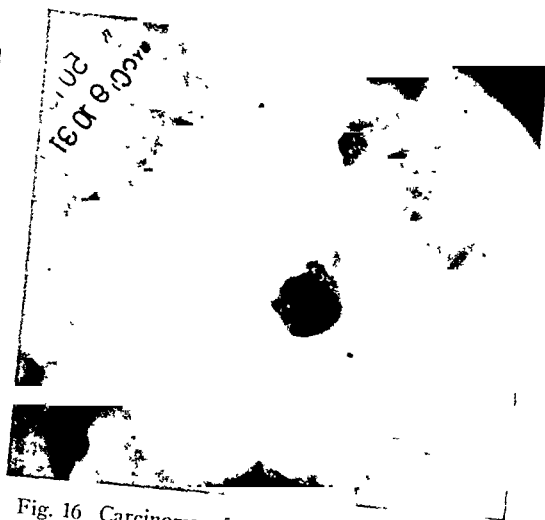


Fig. 16. Carcinoma of prostate, showing metastasis to pelvis.

CHART 6

Bladder Cases	
Total number	28
White	26
Colored	2
Male	2
Female	19
Married	9
Single	23
Ages.—Youngest, 34 years; oldest, 82 years.	5
Results.—Improved, 2; unimproved, 5; dead, 21.	

Comments.—All cases had been previously operated upon, and most of them were hopeless upon admittance. Previous operations consisted of simple suprapubic cystotomy for obstruction, resection of tumor, cauterization of the local bladder lesion, and in some cases radium implantation into the local growth. In only a few cases was radiation therapy possible and high voltage x-rays were employed for this purpose. Failure in these cases was due in most instances to late diagnosis and lack of early supportive irradiation.

CHART 6-A

Prostate Cases	
Total number	50
White	44
Colored	6
Porto Rican	1
Married	1
Single	40

Ages.—Youngest, 50 years; oldest, 74 years.
Results.—Improved, 6; unimproved, 9; dead, 35.
 Eighty per cent had metastases proven by x-rays.
 In 1932, of 23 cases, 20 were Gentiles and three were Hebrews.

Comments.—This lesion was seldom found in the Negro race. Concomitant syphilis was rare. Skeletal metastasis was present in 80 per cent of the cases. Suprapubic cystostomy had been performed in all but a few cases before admission and in the latter after entering the hospital. In only a few instances had radium therapy been employed before admission. Severe skeletal pains and cachexia were pronounced in most cases. In five cases radium therapy and in 40 cases x-ray therapy was employed. Only six cases were improved and, in our opinion, this improvement was due to a combination of surgical relief of immediate local blockage and intensive generalized x-ray therapy to the pelvis.

CHART 6-B

Penis Cases	
Total number	12
White	10
Colored	2
Married	8
Single	4
Gentiles	12
Hebrews	0
Ages.—Youngest, 32 years; oldest, 73 years	
Results.—Improved, 1; unimproved, 1; dead, 10.	
All had had surgical removal of the lesion previous to admittance to the Cancer Hospital.	

Comments.—In no case of carcinoma of the penis was the Wassermann positive. In some cases dissection of the regional nodes was done. High voltage x-ray therapy was used in all cases and local radium applicators were employed in several. Only two patients survived, 10 rapidly succumbing to secondary infection and metastases.

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Total number	78
<i>Distribution</i>	
Face	60
Scalp	3
Skin (various)	3
Neck	3
Metastatic (origin unknown)	9
Males	50
Females	28
White	75
Colored	2
Yellow	1

Ages.—Youngest, 20 years; oldest, 85 years.

Results.—Improved, 30; unimproved, 13; dead, 35.

Comments.—Surface epithelioma occurred in most instances in the 50-70 years age group. The most frequent site of superficial epithelioma was on the face. Pathologically, the usual form was basal-celled. Frequently the lesion started as a small ulceration or keratotic wart. In two instances malignancy developed on an old lupus which had been persistently and frequently treated with x-rays. In spite of the seemingly mild malignancy of the basal-cell type of epithelioma, some of the most destructive lesions were in this group and persisted in spite of treatment by x-rays, radium, or surgery. In most instances the lesion had been over-irradiated. A study of this type of case suggested that the initial treatment failed because it was not intensive enough, and subsequent irradiations produced more and more necrosis, associated with radiation vaccination. In one case malignancy and ulceration followed excessive exposure to diagnostic x-rays. In another, the malignancy developed following excessive x-ray treatments of keloids on a severe burn. In most instances death followed extensive destruction of the skin and



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Female	4
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<i>Ages</i> —Youngest, 26 years; oldest, 73 years.	
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Comments.—All cases were in an advanced condition of the disease, most of them having been admitted because of general weakness. Positive biopsy was had in every case. Most often the condition exhibited a generalized swelling of the lymph glands of the neck, axillæ, and inguinal areas. There were two cases of abdominal Hodgkin's. Several had associated enlargement of the spleen and mediastinal nodes along with generalized superficial adenopa-



Fig 18 Epithelioma of face, treated by radium, x-rays, and plastic surgery, persistent recurrence and necrosis, loss of ear Death

thy. One case showed Hodgkin's nodules in the skin along with involvement of bone. All but one case were treated with high voltage x-ray therapy, some requiring additional supportive treatment by blood transfusions. Treatment was effective in those cases that received protracted multiple doses of x-rays over a long period of time. The one case not treated was too far gone for any therapy.

CHART 8-A

<i>Thyroid Cases</i>	
Total number	7
Male	3
Female	4
White	6
Colored	1
Married	7
Single	0
<i>Ages</i> —Youngest, 41 years, oldest, 69 years	
<i>Previous Treatment</i> —One had had radium therapy, 6 had had operation, 2 had had x-ray therapy	
<i>Results</i> —Improved, 2, unimproved, 2; dead, 3	

Comments—Malignancy of the thyroid occurred almost equally in the two sexes. Diagnosis was made in all cases by biopsy. Six patients had had previous partial thyroidectomy. In one case only could palliative irradiation be employed. In two cases x-ray therapy was used following operation. All patients were treated at the Cancer Hospital with x-ray therapy, of whom only two were improved. In our opinion pre-operative x-ray therapy might have produced bet-

ter results, as it has done in our other clinics where this method has been pursued.

CHART 9

<i>Sarcomas</i>	
Total number	57
<i>Types</i>	
Melanosarcoma	4
Myosarcoma	3
Fibrosarcoma	10
Myxosarcoma	1
Lymphosarcoma	13
Osteochondroma	1
Bone sarcoma	20
Uterus—sarcoma	3
Cervix—sarcoma	1
Liver—sarcoma	1
<i>Bone Sarcoma</i>	
Skull	1
Jaw	1
Antrum	1
Rib	1
Humerus	2
Ilium	3
Femur	7
Tibia	2
Foot	2
<i>Results</i> —Improved, 2, unimproved, 19, dead, 36	

Comments—The most frequent type of sarcoma seen in our series was osteogenic bone sarcoma. Diagnosis was made in most cases by the roentgen examination, confirmed in some instances by operation, either simple exploratory or amputation. Pathological fracture occurred in several cases, especially cases in which the femur was involved (7 instances). In some cases irradiation stayed for a short period of time the progress of the disease. In most cases, however, it was not effective nor was sur-



Fig 19. Epithelioma of face, treated by repeated x-ray doses; recurrence; repeated x-ray and radium treatments; extensive persistent necrosis; radiation Death

gical interference possible. Of the 20 patients, 14 died soon after treatment had been instituted, while the others remained unimproved.

The 13 cases of lymphosarcoma were all proven by operation. The most frequent type of involvement was that of the cervical lymph nodes (5 cases); inguinal and retroperitoneal nodes (2 cases each), and the back, tonsil, intestine (1 each). There was one case of generalized lymphosarcoma. All but one patient were over 35 years of age, and all were in advanced stages of the disease when admitted to the Cancer Hospital. The intestinal case was a white male, aged 37, and the lesion involved the small intestine, which had been resected. X-ray therapy was employed in all cases but gave only temporary relief. Of the 13 cases, 10 died.

Irradiation for fibrosarcoma was only slightly effective, because patients were referred for this form of treatment in an advanced stage of the disease following opera-



Fig 20 Epithelioma of skin—unusual epithelioma of face and hands. Persistent extension in spite of radium therapy

tion for removal of tumor growth. Most lesions involved the fascia of the back.

Myosarcoma in two cases involved the nose; both were operated upon. The third case involved muscle of the face. X-ray therapy was used post-operatively in all cases, with little effect.

The three cases of uterine and one case of cervical sarcoma were diagnosed only following curettage. All four cases were ad-



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White	6
Colored	1
Married	7
Single	0
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<i>Results</i> —Improved, 2, unimproved, 2; dead, 3	

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Lymphosarcoma	13
Osteochondroma	1
Bone sarcoma	20
Uterus—sarcoma	3
Cervix—sarcoma	1
Liver—sarcoma	1
<i>Bone Sarcoma</i>	
Skull	1
Jaw	1
Antrum	1
Rib	1
Humerus	2
Ilium	3
Femur	7
Tibia	2
Foot	2
<i>Results</i> —Improved, 2, unimproved, 19, dead, 36	

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CONCLUSIONS

This study has emphasized that cancer, as an important cause of death, leaves no race immune from it. From the study of special types of certain classes of cancer among races, for example, cancer of the cervix is infrequently found among Jewish women, and cancer of the skin, mouth, and tongue quite uncommon among the colored race. Few men have cancer of the breast.

We also find that the control of cancer depends on how early the condition is diagnosed, and how soon appropriate treatment is instituted. To be effective, treatment,

whether surgery or irradiation or a combination of both, must be intensive and must be properly administered at the outset. Secondary treatments are seldom effective.

In order of frequency in our series, malignancy involved the different organs of the body as follows: Cervix, 17 per cent; breast, 11.9 per cent; stomach, 8.7 per cent; rectum, 8.4 per cent; tongue, 4.8 per cent; face, 4.8 per cent; prostate, 4 per cent; ovary, 3 per cent; esophagus, 2.1 per cent. The other organs were less frequently involved.

A large properly organized custodial hospital is necessary for the care of cancer patients and when so established may succeed in improving many cases committed to its care.

THERAPEUTIC FEVER PRODUCED BY DIATHERMY¹

ITS PRESENT DEVELOPMENTS AND FUTURE POSSIBILITIES

By J. CASH KING, M.D., MEMPHIS, TENNESSEE

BEFORE discussing the diathermic method of producing therapeutic fever, it will be necessary to consider in a general way some of the facts pertaining to fever itself.

Fever is a reaction within the body characterized by certain symptoms and signs, the most outstanding of which are an elevation of the general body temperature and an increased metabolic rate. These reactions represent an imbalance of those physical and chemical mechanisms which maintain the normal temperature of the body in health. The physical operates through the sympathetic nervous system, controlling heat dissipation from the body by its vasomotor effect on the peripheral arterioles. The chemical increases or decreases the amount

of heat production through metabolic processes.

BENEFICIAL EFFECTS OF FEVER

Within the last decade, medical science has recognized that pyrexia is a defense reaction which protects the body against injurious agents by facilitating the production, and hastening the action, of substances or specific antibodies found in the body that combat bacteria and their toxic products. It is apparent that other factors are also at work in induced pyrexia. Sustained high temperature causes peripheral vasodilatation, and has a direct thermic effect on the causative infectious organisms.

Rolly and Meltzer (1), as well as others, have found that animals kept at a high temperature in a thermostat room develop a much more effective defense against intoxi-

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.



Fig. 21. Hodgkin's disease; progressive involvement in spite of extensive and persistent x-ray therapy. Death.

vanced and died in spite of intensive irradiation.

The melanosarcomas involved the eye in two cases, and the skin in two cases. Surgical interference plus irradiation was unsuccessful in controlling the eye lesions. The skin cases involved the limbs, with generalized metastases. Irradiation was of no avail in any of the cases.

CHART 10.—PATIENTS IN CANCER HOSPITAL,
OCTOBER, 1932

Epithelioma, scalp.....	2
Epithelioma, forehead.....	1
Epithelioma, face.....	4
Malformation, face.....	1
Cancer, skin.....	1
Epithelioma, skin (abdomen).....	1
Cancer, cervical gland.....	1
Burn of neck.....	1
Epithelioma, lip.....	7
Epithelioma, cheek.....	6
Epithelioma, mouth.....	5
Epithelioma, tongue.....	5
Luetic ulceration, tongue.....	1
Mixed tumor, left parotid.....	1
Cancer, antrum.....	2
Cancer, mandible.....	1
Cancer, pharynx.....	2
Cancer, tonsil.....	1
Cancer, larynx.....	6
Cancer, thyroid.....	2
Cancer, lung.....	2
Cancer, breast.....	29
Cancer, esophagus.....	3
Cancer, stomach.....	11
Cancer, colon.....	1



Fig. 22. Melanosarcoma of foot; metastasis to inguinal area. Recurrence following local removal and cauterization. Death.

Cancer, sigmoid.....	2
Cancer, rectum.....	20
Cancer, anus.....	1
Rectal fistula.....	1
Rectal abscess.....	1
Cancer, ovary.....	5
Cancer, uterus.....	1
Cancer, cervix.....	40
Cancer, vulva.....	1
Cancer, bladder.....	5
Cancer, prostate.....	14
Cancer, scrotum.....	1
Cancer, testicle.....	1
Epithelioma, penis.....	3
Hyponephroma.....	1
Osteosarcoma, face.....	1
Sarcoma, femur.....	1
Hodgkin's disease.....	2
Kaposi's disease.....	2
Mycosis fungoides.....	1
Tumor, brain.....	1

In the preparation of the statistical figures cited in this study I had the valuable assist-

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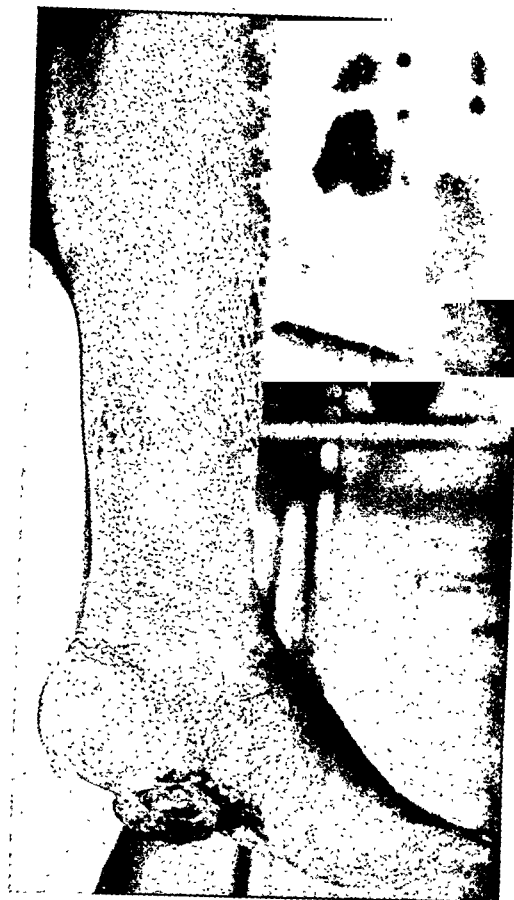


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Luetic ulceration, tongue.....	1
Mixed tumor, left parotid.....	1
Cancer, antrum.....	2
Cancer, mandible.....	1
Cancer, pharynx.....	2
Cancer, tonsil.....	1
Cancer, larynx.....	6
Cancer, thyroid.....	2
Cancer, lung.....	2
Cancer, breast.....	29
Cancer, esophagus.....	3
Cancer, stomach.....	11
Cancer, colon.....	1

Cancer, sigmoid.....	2
Cancer, rectum.....	20
Cancer, anus.....	1
Rectal fistula.....	1
Rectal abscess.....	1
Cancer, ovary.....	5
Cancer, uterus.....	1
Cancer, cervix.....	40
Cancer, vulva.....	1
Cancer, bladder.....	5
Cancer, prostate.....	14
Cancer, scrotum.....	1
Cancer, testicle.....	1
Epithelioma, penis.....	3
Hyponephroma.....	1
Osteosarcoma, face.....	1
Sarcoma, femur.....	1
Hodgkin's disease.....	2
Kaposi's disease.....	2
Mycosis fungoides.....	1
Tumor, brain.....	1

In the preparation of the statistical figures cited in this study I had the valuable assist-

comfort to the patient. The refinement of control permits the duplication of temperature curves. By the use of a special voltage divider, constructed by H. D. Roop, two patients can be treated at the same time, which reduces the time and expense to almost one-half.²

The electrodes must be as large as possible, must fit snugly to the skin surface of the patient, and should be placed so that the distance between the anterior and posterior electrodes is equal at all points. Our electrodes, which almost completely cover the anterior and posterior surfaces of the torso, are held in place by a jacket fastened with elastic straps. It is not necessary to use any conductive material on the electrode surface.

Treatment is carried out by placing the patient in bed, carefully applying the electrodes, and then insulating the body and extremities against heat dissipation by wrapping him thoroughly in rubber sheets and blankets. Rubber sheets are required because of the profuse sweating that occurs during the treatment. Since the patient experiences considerable discomfort when the temperature reaches 102 or 103° F., from 3 to 6 gr. sodium amytal per rectum are given immediately preceding treatment. If at any time during the treatment other sedatives are necessary, we advise the use of an H.M.C. tablet No. 1, rather than morphine sulphate alone, because of the depressing effect which the latter has on respiration.

The current is gradually increased to reach from 5,000 to 7,000 ma. by the end of 15 minutes. This milliamperage is maintained until the temperature is within one degree of the desired elevation, and the current is then cut off. The rise is slow at first, but 104° F. is usually reached by the end of one hour. The temperature, pulse, and respiration are recorded before the treatment

is begun, each 15 minutes during the contact of the current, and thereafter until the temperature returns to normal. Thorough wrapping of the patient prevents any appreciable fall in the temperature during a period of two hours after the current is cut off. However, if a fall does occur, the current can again be turned on for short periods. To lower the temperature of the patient, all or part of the insulation may be removed.

PATHOLOGIC PHYSIOLOGY OF PYREXIA

When the heat-producing currents are passed through the highly vascular tissues of the chest and abdomen, the temperature of the blood in these regions is elevated. As the heated blood reaches the heat-regulating centers of the brain, the latter attempt cooling of the blood through the physical regulatory processes. Marked dilatation of all peripheral vessels occurs, the skin becomes very hyperemic, and sweating is profuse. Dissipation of the heat is prevented by the body insulation. As a consequence, the blood returns at a higher temperature than normal, only to be reheated and again circulated. The increased pulse rate further augments dilatation of the peripheral vessels, with increased rate of blood flow to and from the heart. After a certain degree of fever is induced, the increased metabolism, with general augmentation of the chemical processes in the body, materially assists in heat production, as is shown by the continued rise in temperature after the current is cut off. In other words, a recapitulation of the history of events which occur in infectious disease characterized by pyrexia is enacted and maintained. The essential difference between the vascular reactions of the two is principally quantitative.

Syphilis.—Thermic fever produced by diathermy has been used in all forms of syphilis, but more extensively in the treatment of paresis. The lesions in syphilis repeat the essential pathology of the primary lesion,

²An illustration of this device appeared in an article by J. F. Hamilton, "The Super-power Diathermy Machine with an 'Output Divider,'" *RADIOLOGY*, January, 1932, XVIII, 133-135.

cations and infections than those left outside at ordinary temperatures. By injecting small doses of bacteria or toxins as they occur in diseases, the heated animals show many advantages over the controls by living longer; many of them survive doses that inevitably kill the control animals.

It is true that infectious diseases, accompanied by rise of temperature, are self-limiting. On the other hand, it is equally evident that afebrile infections are not self-limiting. Syphilis, gonorrheal infections, and the arthritides are included in this category. Efforts to control these with artificial fever produced by diathermy have met with noteworthy success.

Repeated experiments by Bessemans (2) have proved that temperatures of 40° C. for two hours, or 42° C. for one hour, have an intense destructive action upon emulsions of active syphilitic virus, prepared from specific lesions of animals or man. If the syphilitic testicles of rabbits are treated with heat in the form of a continuous bath at these temperatures, the orchitic primary manifestations of syphilis are cured with certainty, without apparent danger to the organ or the general organism. The treponema become immobile and disappear after 24 hours or more, and the tissues of the organ rapidly resume their normal microscopic aspect.

According to the work of Corbus and O'Connor, reported by Pugh (3), higher temperatures—from 46 to 47° C.—for from 20 to 40 minutes are necessary for the destruction of the gonococcus, either *in vivo* or *in vitro*.

METHODS OF INDUCING THERAPEUTIC FEVER

You are already familiar with most of the methods of inducing fever used in the past; for this reason they will not be discussed in detail here. Among these may be mentioned malarial inoculation, infection of the patient with rat-bite fever and relapsing

fever, and injection of foreign proteins, vaccines, and other toxic substances.

Some of the chief objections to these procedures are:

1. They necessitate giving the patient a disease which may be difficult to cure, and, in some instances, do irreparable injury to the vital organs of the body.
2. The desired strain of plasmodia, or other infectious agent, often is not available.
3. In many cases, the febrile paroxysms stop spontaneously before the desired reaction is produced. Others may have only slight elevations in temperature, rather than the typical febrile paroxysms.
4. One has no means of controlling the intensity and severity of the febrile attacks without stopping them altogether.
5. Medicinal treatment and some of the febrile diseases cannot be used simultaneously.

6. They offer no means of producing localized temperature of sufficient intensity to kill organisms such as the gonococcus.

In an effort to overcome these difficulties, a new method of inducing therapeutic fever has been presented in the last three years. I refer to hyperthermia, induced by the high frequency diathermy machine, a form of treatment devised by H. D. Roop and the author in 1928. It was first employed in the treatment of paresis at the Western State Hospital in Bolivar, Tennessee, by Dr. E. W. Cocke and the author (4) and the results and technic were reported in 1929. As the technic has been somewhat modified since our first report, I feel that it should be reviewed at this time.

TECHNIC

A diathermy machine of the vario-frequency type, capable of producing and maintaining a load of 10,000 ma., is essential. The high capacity machines make it possible to bring about the desired elevation in temperature in much shorter time, with less dis-

general diathermic fever. The active electrode for introduction into the urethra, cervix, or fornices, is small, and of the Chapman, Corbus, or Peacock type. A thermophore is provided for a thermometer, so that an accurate temperature may be maintained and observed. The method is more suitable for the treatment of gonorrhea in the female. Unfortunately, in the male, the sensitivity of the urethra will not permit of a temperature of sufficient intensity to accomplish the desired end-result.

Thrombo-angiitis Obliterans.—The principal objection to foreign proteins, as used by most therapists in the treatment of this disease, is that the associated chills and vasoconstriction cause the patient much pain and are conducive to thrombosis. Diathermy offers the best means of inducing therapeutic fever in this condition by dilating the capillary bed to the fullest extent without an initial vasoconstriction. Consequently, relief of pain, claudication, and healing of superficial ulcers occur without risk of serious complications.

Bronchial Asthma.—Leopold and Stewart (8), Miller and Piness (9), and Feinberg, Osborne and Afremow (10) have observed that, in chronic bronchial asthma, intercurrent febrile reactions of a certain intensity frequently produce complete clinical remissions which last throughout the fever and for some time afterward. These authors have reported 31 cases in which they induced febrile reactions with diathermy in an effort to bring about similar clinical remissions without the use of infective agents. The results have been encouraging, but in all cases they were not equal to those observed in intercurrent febrile diseases. In many, the height, duration, and frequency of the induced fever reactions did not simulate the temperature curves observed in disease, nor were they wholly in accord with the diathermic treatments usually employed. The improvement seen in these cases was, perhaps, due to the effect of diathermy on

the sympathetic nervous system, which brought about dilatation of the bronchioles, and probably altered the sensitivity to certain substances. It is hoped that the proper temperature curves will be found on further study, as well as those types of cases in which the treatment is most effective. Thus, another useful agent to combat this prevalent and dreaded disease may be perfected.

Multiple Sclerosis.—In a recent publication, Schmidt and Weiss (11) report their observations with diathermic fever in the treatment of sub-combined degenerations, encephalitis, and multiple sclerosis. They state that probably their best results were obtained in multiple sclerosis, in which such symptoms as spastic paraplegia, intention tremors, ataxia, and vesical disturbances were remarkably improved. Other signs, such as scanning speech, nystagmus, and optic atrophy, were not markedly benefited. They observed remissions that simulated, or might prove to be, a cure, and their results in this disease far exceeded their expectations. Achievements in the other two mentioned conditions were less encouraging.

Chorea.—Since Sutton (12) reported gratifying results obtained in the treatment of chorea by induction of fever with vaccines, this disease also may be added to the list of those which may be amenable to diathermic therapy.

SUMMARY

1. The value of febrile reactions as a therapeutic measure can no longer be denied.
2. The appreciation of the ultimate consequences of this form of treatment is dependent on one's knowledge of the physiologic changes produced by hyperthermia, as well as an understanding of the pathology of the disease to which heat is applied.
3. The diathermic method has many advantages over other procedures previously used to bring about the desired febrile reactions. Better results have been made pos-

the hard chancre. These changes are predominantly vascular and perivascular, consisting of lymphoid and plasma-cell infiltrations. The ischemia produced by the reduction in the caliber of the lumina of the vessels ultimately results in chronic fibrosis, which is the chief end-result of all syphilis (5). These treatments combat syphilis, not only through the spirocheticidal effect of heat upon the organisms, encased as they are in fibrous connective tissue, but they also alter the pathologic changes themselves by sustained vasodilatation, which increases the blood supply to the ischemic area.

Since febrile reactions have been most successfully used in paresis, our initial application of hyperthermia was in this disease. The results in our first series of cases were better than those obtained with the use of malarial injections, and our subsequent cases, as well as those reported by others, have shown an increasingly greater percentage of remissions. By averaging all of the cases reported to date, we note that 38 per cent have shown remissions.

The treatment has been employed with equal success, but less extensively, in other forms of neurosyphilis.

In an effort to render the treatment more effective, and possibly to offer a complete cure for the disease, we recommend intravenous antisyphilitic medication just preceding the febrile reaction. When used together, hyperthermia, vasodilatation, and medication within the blood stream augment each other without any additional toxicity. That is to say, the specific drug is brought in better contact with the seat of most active pathology by virtue of the vascular dilatation, and, in this way, the drug has access to the causative organisms at a time when the resistance of the latter is already lowered by the elevated temperature. Any febrile reaction caused by the antecedent medication is observed during the routine recording of temperature.

The Arthritides.—In the arthritides,

Pemberton (6) has shown that the temperature of the peripheral tissues, particularly of the extremities, is subnormal, due to impaired circulation through the capillary bed in these tissues. He has demonstrated the effect of impaired circulation on bony structures by experiments on dogs. After tying off the blood supply to the patella, he observed changes in this bone similar to those occurring in arthritis. A lowered basal metabolic rate, averaging minus 20, accompanies arthritic changes in the joints. Diathermic fever, by increasing the blood flow through the capillary bed and inducing a high metabolic rate, directly antagonizes the incident pathologic process. Our work with diathermy in this disease, both in chronic hypertrophic and atrophic cases, has been rewarded with most striking results. Every patient has noticed some relief of pain, an increased motion of joints, improved color of skin, and a state of general well-being. When recurrences have been observed after a quiescent period of three months or longer, we believe they have been caused by too prolonged intervals between the treatments. We advocate the continued use of treatments long after complete relief has been obtained, and a gradual increase of the length of time between treatments. Other established therapeutic measures should be combined with this procedure.

Gonorrheal Infections.—Heat is one of the oldest forms of therapy for gonorrheal infection. Until recently, however, few, if any, cases have been cured by heat alone. It must be remembered that, in this disease, elevations of the general body temperature are insufficient; to destroy the gonococcus, they must be supplemented by a localized thermic fever of from 46 to 47° Centigrade. Duncan (7) has described the most useful means of inducing local temperature of this intensity; its success is dependent upon the size and arrangement of the indifferent or body electrodes. This method is somewhat similar to that of electrode application in

not only prevents sparking from electrodes to skin, but also permits the operator to raise the current rapidly to its maximum. Secondly, due to the large size and distribution of the electrodes, only one-half of the recommended milliamperage is applied per square inch of active electrode surface. This safety factor minimizes the risk of burns in the hypertensive cases and reduces the possibility of syncope in the hypotensive. No specialized skill is essential to the proper use of the machine, as trained technicians can operate it satisfactorily.

The results obtained to date in the treatment of syphilis, especially paresis, are commensurate with those secured from malarial inoculations. While the technic of the malarial injections is quite simple, it is not always the simplest procedure which is the best. Once established, collateral infections are sometimes quite difficult to abolish. It must be emphasized that the injection of viable pathogenic organisms of any character to induce pyrexia in afebrile diseases is hazardous. Pilcz reported 141 cases of paresis treated by malarial inoculation during 1919 and 1920, with 51 complete remissions. However, 15 of the patients died under treatment. The mortality from the use of diathermy is almost negligible. Moreover, atypical febrile reactions, such as may occur from malarial treatment, are of no benefit in the destruction of spirochetes in the body, encysted as they are by fibroblastic proliferation.

In conclusion, while the use of thermic fever in the treatment of thrombo-angiitis obliterans, bronchial asthma, and multiple sclerosis is yet in the experimental stage, I must say that chronic rheumatoid arthritis and gonorrheal infections, the latter in the female, are quite amenable to pyretotherapy, and the results obtained are second only to those in neurosyphilis itself.

DR. LEWIS G. ALLEN (Kansas City, Kan.): I have had no personal experience with this type of endeavor. One of our group has been doing some work and for that reason I would like to ask Dr. King a question.

Regarding the application of the two electrodes to patients of varying habitus, it struck

me that the electrode applied to the chest of the patient with a scaphoid abdomen was much further away than the electrode applied to the abdomen. At least, I have argued with my associates that there should be some difference in the size of the two electrodes or a resistance cut in between the upper and lower electrodes, to compensate for the difference in thickness of the patient's abdomen in comparison with the thickness of the chest. Likewise, it would appear, from the technical standpoint at least, that, in the patient with the large abdomen, the electrodes applied to the abdomen would be further away than those applied to the chest. Are these factors of significance?

Is the criterion of a falling blood pressure incident to the inception of the high temperature of as great importance as has been reported?

DR. C. E. PIERSALL (Reno, Nev.): I want to ask how long it takes to get results in chorea, which I have seen clear up by use of the ordinary diathermy machines.

I noticed in Palo Alto, Calif., a new type of diathermy machine which is made with thermionic tubes. I cannot tell you the way it is hooked up, but there is no spark gap or frequency. It produces a very smooth current and you can run the current higher than with the ordinary high capacity diathermy machine and very quickly.

A machine of this type is being used by Dr. Powers, of Palo Alto, which may be something to prove of interest to all of you in the future.

DR. KING (closing): Skin burns produced by electrodes have not been a troublesome factor in our own work since we began the use of extremely large electrodes. However, I do know that these burns still occur occasionally with some users of this form of treatment. They can be avoided if the anterior electrode is made as much as 25 per cent larger than the posterior electrode and if care is used in applying the electrodes to the body of the patient.

Another point in technic that I want to emphasize is the necessity of careful observation of the patient, with frequent checks on the temperature, pulse, and respiration at all times

sible by the improvement in apparatus and technic.

4. The results obtained with diathermic fever in paresis indicate that it is the treatment of choice at the present time. Pyrexia causes profound dilatation of the arterioles and capillary bed, which are the seat of the most active pathologic changes in syphilitic infections. By giving intravenous anti-syphilitic medication immediately before diathermy, we are able to combat the disease at a time when its pathologic processes are altered and the resistance of the treponema is lowered by the high temperature. Thus we hope to cure the disease in its incipency, or at least to prevent the serious complications of latent syphilis.

5. The improvement observed in chronic arthritis so far has been most encouraging. We attribute this to the changes in the existing pathologic process brought about by the reactions to fever.

6. In gonorrhea, diathermy combats the progress of the disease by the bactericidal effect of heat and through the increased vascularity, which hastens resolution of chronic processes. The proper application of the treatment in the female has brought gratifying results, but thus far its use in the male has not been so encouraging.

7. Although a distinct improvement in symptoms is to be derived from the use of diathermy in the treatment of thromboangiitis obliterans, bronchial asthma, multiple sclerosis, and chorea, the results obtained up to now are not commensurate with those secured in the above-mentioned diseases. We are hopeful, however, that future developments in technic will contribute to a greater success.

CONCLUSIONS

Therapeutic fever produced by diathermy has proved a valuable aid in the management of a number of diseases. The ultimate accomplishments of this form of therapy, which is still in its infancy, will depend upon

close study and conservative reporting of results.

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DISCUSSION

DR W. W. ROBINSON (Memphis, Tenn.): Diathermy, with the superpower, vario-frequency machine, offers a method of heat production deep within the tissues, under a refinement of control, which is almost perfect, and by means of which the exact type of temperature curve for each individual can be duplicated at will. There is no danger of blistering the skin, for two reasons. First, the resistance for a given voltage with this type of machine is much less than in other types. This

creasing the slit ratio further produces an additional increase in the efficiency of the diaphragm.

However, the slit depth can not be increased without producing impairment in definition, and therefore the present construction of a Potter-Bucky diaphragm is such as to represent a balance between two extremes, in which the slit ratio permits a radical elimination of the scattered radiation without a great sacrifice in definition. To test these effects on definition, Wilsey prepared a set of gold-plated screens with a mesh-variation ranging from 110 to 280 strands per inch. These were mounted in a row and used as a test object. The shadow of the finest mesh which could be resolved by the eye was determined after varying slit depth, slit width, the distance between the scattering material and film, and the distance of the test object above the slits. The distance between the object and the film was found to be of extreme importance; hence the necessity of reducing the distance between the cover of the diaphragm and the grid level, and the distance between the film and the grid.

Because bakelite, or any other known radiotranslucent substitute, is flexible and yields under the influence of superincumbent weight, it is common practice to allow generously for this in order to prevent friction between the cover and the grid during the grid stroke.

Many movable Bucky diaphragms have been prepared with mounting rails, and ample clearance must be allowed for a mobile unit of this kind. The writers have seen many in which the distance between the object and film was so great as to practically negate the beneficial effects of the Bucky. The sacrifice in definition becomes sufficient to equal or outweigh the advantages of contrast accruing from the reduction in scattered radiation.

We have long felt the need for a mobile

Potter-Bucky unit, but we have been hesitant about constructing such a unit because of the difficulties arising in its construction in maintaining a short object-grid distance. Recently, we have been successful in solving this difficulty, and the efficiency of this Bucky as regards elimination of scattered radiation and preservation of definition is the same as that of the diaphragm without the mobile feature.

DESCRIPTION OF THE MOBILE FEATURES OF THE POTTER-BUCKY DIAPHRAGM

The slit ratio of this diaphragm¹ was approximately 0.16 (slit depth of 0.95 cm. and slit width of 0.16 cm.). The thickness of each individual grid was approximately 0.01 centimeter. The bakelite cover was removed. Ball-bearing rollers² were mounted at the four corners of the Bucky. Two of these for the front side of the table have a concave bearing surface for operation along a steel rail, with a convex upper bearing surface. The other two rollers have a flat bearing surface to track along a flat rail running along the rear side of the table. These rails, which were machined in our shop, were prepared for mounting to a wooden table of the usual proportions for radiographic work (Fig. 1). They were mounted at such a level that, with the Bucky in place, there was approximately 0.9 cm. ($\frac{3}{8}$ in.) between the top surface of the Bucky (with the cover removed) and the under surface of the table top. The table top of wood was 5-ply veneer, with a thickness of approximately 0.8 centimeter. This type of top was selected because of its relative inflexibility and its low cost.

The sag which such a top is certain to show causes no disturbance in the movement of the grid during exposure because of the generous allowance for operating space be-

¹This diaphragm, with its housing, was one obtained from the Liebel-Flarsheim Company.

²Also obtained from the Liebel-Flarsheim Company.

during the fever reaction and until the temperature returns to normal. If this precaution is not observed—that is, if frequent checks of the temperature are not made after the current is cut off and until the temperature returns to normal—sooner or later serious accidents will occur.

The fall in blood pressure observed during the treatment is undoubtedly due to the dilatation of the peripheral arterioles, which decreases the resistance of the blood flow through the capillary bed.

I, personally, have not had any experience with febrile reactions produced by diathermy in the treatment of chorea. In referring to this disease, I merely mentioned the results obtained by others with the use of vaccines.

The radiotherm, which was mentioned by Dr. Piersall, has been in use since 1929. With this apparatus, the patient is placed between two large condensers, thus eliminating the necessity of applying electrodes to his body. However, it is necessary to pass hot air over the patient's body in order to dry off the perspiration as fast as it forms. It has occurred to me that this hot air has a great deal to do with the elevation of the temperature of the patient.

No doubt such points are being worked out by the men using these machines. In the near future, reports from these, and other experimenters with the different methods of producing a therapeutic fever, will enable us to choose the most simple and safe method.

A STUDY OF THE CHANGES IN DEFINITION OCCURRING WITH THE BUCKY DIAPHRAGM OF THE MOBILE TYPE*

A NEW DEVICE FOR CORRECTING THE CHIEF DEFECT RESULTING FROM ITS MOBILE CHARACTER

By WALTER W. FRAY, M.D., and WILLIAM T. HILL

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THE Potter-Bucky diaphragm has found an increasing use due to its remarkable efficiency in eradicating scattered radiation over a large area of roentgenographic film. The writers can do no better than to call attention to the detailed, accurate analysis of the physical principles underlying this diaphragm by Wilsey (1922) (1). Briefly, these may be summarized as follows: Since the quality of the scattered radiation differs but little from the primary, the only effective method lies in its reduction by diaphragms, either by preventing its formation by limiting the volume of material irradiated, as in the case of a cone, or by screening it from the film after its formation by means of a diaphragm of the Potter-Bucky type placed between the source of the scattered radiation and the

film. Only the latter method permits the use of a large film. The efficiency of this diaphragm in removing scattered radiation has been found by Wilsey to be independent of the distance between the scattering material and the grid, and remains practically unaffected by the presence of the wood strips used in maintaining proper alignment of the lead grids. The ratio between the slit width and depth, on the other hand, was found to be of utmost importance. The greater the slit depth in proportion to its width, the more marked was its efficiency. To illustrate, the employment of a slit ratio of 0.2 (slit width equal to one-fifth of its depth) resulted in a reduction of the ratio of the diffuse to focal radiation from 4.9 (without the diaphragm) to 0.65 with the diaphragm. This degree of reduction results in an efficiency of 86 per cent. De-

*Accepted for publication July 5, 1932.

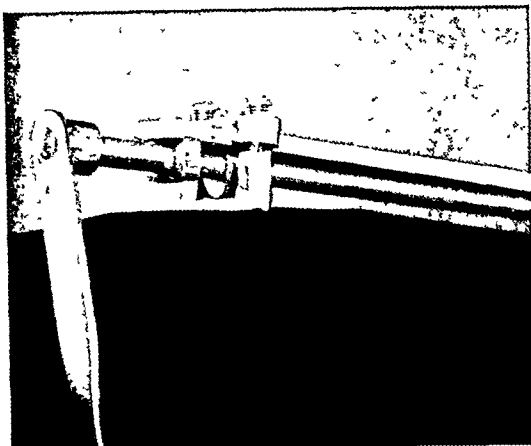


Fig. 2. Elevating mechanism with eccentric cam and shoe.

(approximately 1.3 cm., or $\frac{1}{2}$ in. in thickness) is at the level of the grids when the diaphragm is in place, and is used in order to strengthen this side of the table without increasing the distance between the underside of the table and the grid level. The completely assembled table, with the Potter-Bucky diaphragm in place, is shown in Figure 4.

DEFINITION TESTS WITH AND WITHOUT DEVICE

Method.—A preliminary set of films was obtained, using a set of wire mesh screens³ as a test object, with the same diaphragm, under the following conditions: (1) Ordinary Potter-Bucky diaphragm with bakelite cover; (2) mobile diaphragm without the elevating device, substituting the wood table top for the bakelite cover; (3) the same diaphragm under the same conditions, employing the elevating device. The height of the test object above the bakelite top of the diaphragm or the table top was varied as follows: 0.0, 2.5, and 5.0 centimeters. Films were obtained both with and without

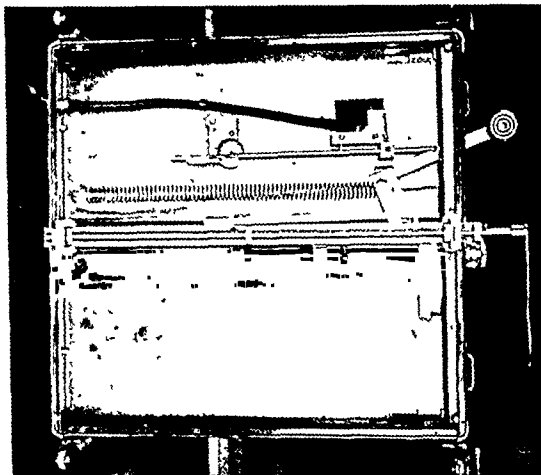


Fig. 3. Showing underside of the diaphragm with the elevating mechanism attached. The under surfaces of the two shoes are noted at either end of the diaphragm housing.

fluorescent screens. The same Coolidge tube of the radiator type with a round focal spot of 33 sq. mm. was used in all tests. The type and amount of scattered material (12.7 cm., or 5 in., of water) was constant throughout all the experimental tests. The wire mesh screens were numbered from 1 to 17, beginning with the coarsest. Direct exposure films of the test object without the diaphragm were likewise secured.

The results are indicated in Table I. It will be noted that only the first five or six coarsest screens could be identified in the series without the fluorescent screens, and only the first three or four when fluorescent screens were employed. The grading of the wire screens was such as to prevent a finer analysis of the effects produced because of the type of grading at the coarse end of the series of screens. However, it is apparent that the films obtained on the mobile Bucky table, without the use of the elevating device, do not equal in definition the ones obtained with the same diaphragm when made stationary with the usual bakelite top. When screens are used, the definition is so seriously impaired that these finer

³We desire to express our indebtedness to Mr. Rex B. Wiley for the use of his graded set of gold-plated, wire mesh screens, in making the preliminary tests of the diaphragm. His valuable suggestions concerning this work are likewise appreciated.

tween the underside of the table top and the grid diaphragm. To test this point, during the construction of the unit, a short, stocky man 5 feet 6 inches in height and weighing 220 pounds was placed in the cen-

the bearing surface of these cams operated directly against the rails and served to lift the entire diaphragm, with its rollers, from the track. During the movement of the diaphragm along the track these cams were

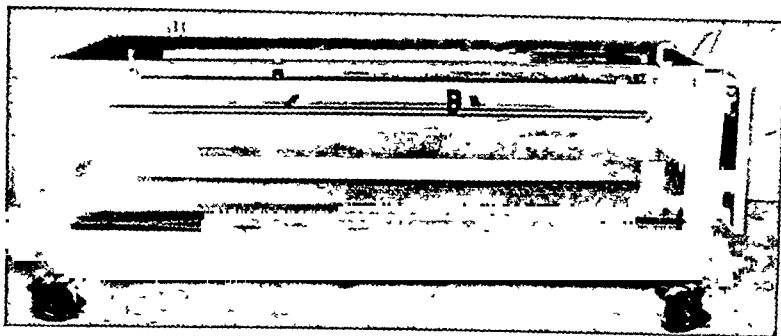


Fig. 1. Table with rails (A and B) serving as a track for the diaphragm. The top of the table and diaphragm have been removed. The steel bar (C), used to strengthen the table, is at the level of the grids when the diaphragm has been elevated into position.

ter of the table—there was no friction at any point along the entire run of the Bucky. But the presence of this wide space between the table top and the grid increases the object-grid distance. This, Wilsey has clearly demonstrated, materially decreases the definition. We wished to sacrifice nothing in definition in securing mobility, and an elevating mechanism was devised which raised the Potter-Bucky diaphragm from the tracks the necessary distance, so that the table top actually rested firmly upon upper edges of the Bucky housing. By means of this arrangement the conditions became practically the same as when the stationary bakelite top diaphragm was used.

The elevating device, consisting of a steel rod (1.3 cm. or 0.5 in. in diameter) with eccentric cams as illustrated in Figure 2, was mounted in the under surface of the center of the Bucky housing by means of a steel strip. These cams measured approximately 2.8 cm. (1 1/8 in.) in the longer diameter, and 1.9 cm. (0.75 in.) in the shorter diameter. During the first part of the work

so mounted as to be free of the track. Because of the tendency of the Bucky diaphragm to slide along the track when the thrust of the cam comes against the track during the act of elevating the diaphragm, shoes (Fig. 2) were devised with lower surfaces to conform with the bearing surface of the rails, and with a flat upper surface against which the cam acted. These shoes were fastened to the frame of the device by two steel pins on either side of the cam. A spring at the top of each pin held the shoes snugly down against the rail, preventing it from jumping the track when the diaphragm was moved. A lever handle was fastened to the near end of the steel rod, which turns the cam. The leverage is such that the amount of pressure required at the handle, to successfully accomplish complete elevation of the diaphragm, is slight. The appearance of the underside of the diaphragm, with the elevating device attached, is shown in Figure 3.

The film tray slides out immediately below the steel bar C in Figure 1. This bar

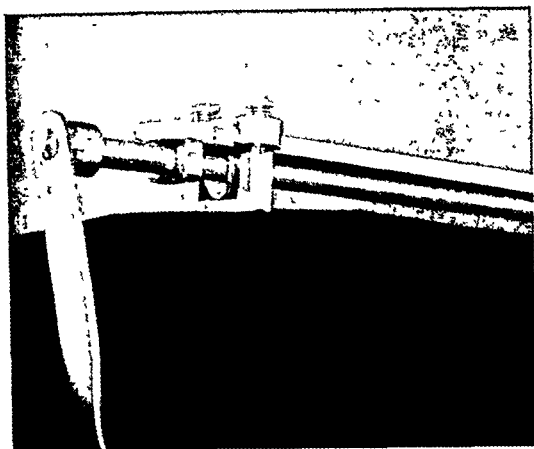


Fig. 2. Elevating mechanism with eccentric cam and shoe.

(approximately 1.3 cm., or $\frac{1}{2}$ in. in thickness) is at the level of the grids when the diaphragm is in place, and is used in order to strengthen this side of the table without increasing the distance between the underside of the table and the grid level. The completely assembled table, with the Potter-Bucky diaphragm in place, is shown in Figure 4.

DEFINITION TESTS WITH AND WITHOUT DEVICE

Method.—A preliminary set of films was obtained, using a set of wire mesh screens³ as a test object, with the same diaphragm, under the following conditions: (1) Ordinary Potter-Bucky diaphragm with bakelite cover; (2) mobile diaphragm without the elevating device, substituting the wood table top for the bakelite cover; (3) the same diaphragm under the same conditions, employing the elevating device. The height of the test object above the bakelite top of the diaphragm or the table top was varied as follows: 0.0, 2.5, and 5.0 centimeters. Films were obtained both with and without

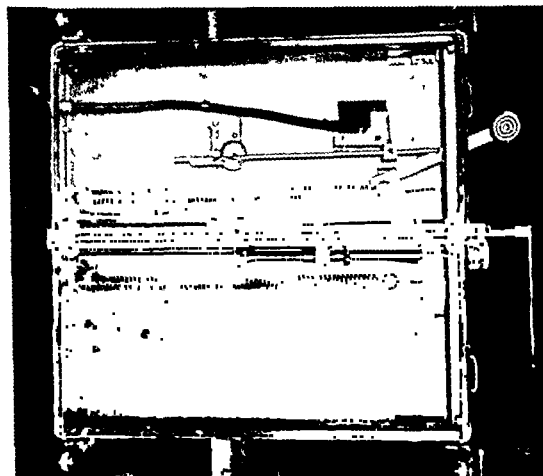


Fig. 3. Showing underside of the diaphragm with the elevating mechanism attached. The under surfaces of the two shoes are noted at either end of the diaphragm housing.

fluorescent screens. The same Coolidge tube of the radiator type with a round focal spot of 33 sq. mm. was used in all tests. The type and amount of scattered material (12.7 cm., or 5 in., of water) was constant throughout all the experimental tests. The wire mesh screens were numbered from 1 to 17, beginning with the coarsest. Direct exposure films of the test object without the diaphragm were likewise secured.

The results are indicated in Table I. It will be noted that only the first five or six coarsest screens could be identified in the series without the fluorescent screens, and only the first three or four when fluorescent screens were employed. The grading of the wire screens was such as to prevent a finer analysis of the effects produced because of the type of grading at the coarse end of the series of screens. However, it is apparent that the films obtained on the mobile Bucky table, without the use of the elevating device, do not equal in definition the ones obtained with the same diaphragm when made stationary with the usual bakelite top. When screens are used, the definition is so seriously impaired that these finer

³We desire to express our indebtedness to Mr. Rex B. Wiley for the use of his graded set of gold plated, wire mesh screens, in making the preliminary tests of the diaphragm. His valuable suggestions concerning this work are likewise appreciated.

changes, due to changes in object-grid distance, are largely obscured by the effect of the screens.

Since the changes are difficult to study by means of this particular test object, a

of the wires, with notches to indicate centimeters and millimeters.

The exposures were all made through 12.7 cm. (5 in.) of water, contained in a round aluminum vessel with thin walls. The

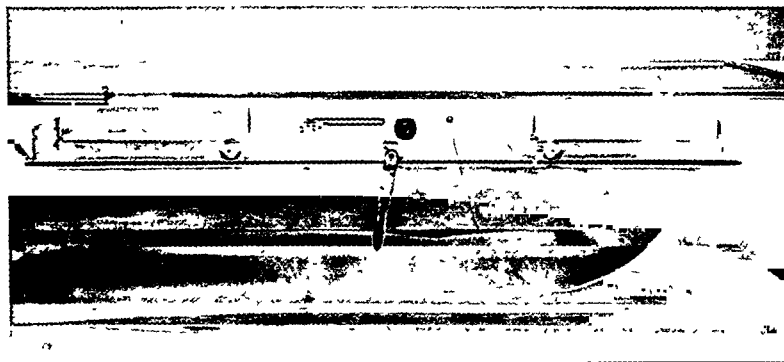


Fig. 4. Table with Potter-Bucky diaphragm in place beneath the table top of 5-ply veneer wood. By using the elevating mechanism, the distance between the object and the grids remains practically the same as that obtained when a fixed diaphragm is used with a bakelite cover.

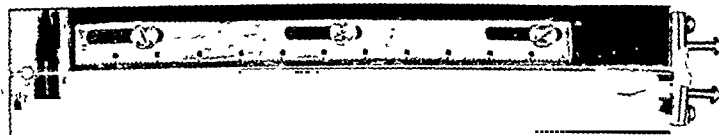


Fig. 5. Test object consisting of two wires converging at the lower end of the radiopaque scale. Their tension can be altered independently by adjusting the machine screws at the other end of the object. A collar placed about the open end of the wires permits varying degrees of separation of the wires to accommodate for any desired technic.

new test object was devised. Two fine wires (No. 32 B & S constantan) were approximated at one end of a bakelite strip (3.0 cm. \times 16.0 cm.). The other ends of these wires were slightly separated. Their tension could be varied independently of one another at will by four adjusting screws (Fig. 5). The wire, composed of an alloy (constantan) of copper (60 per cent) and nickel (40 per cent) is radiopaque and can be identified even when a thick layer of scattering material is employed. An opaque centimeter scale is mounted along the course

test object was placed at the bottom of the vessel and 5 cm. above this level to determine the effect of increasing the object-grid distance. The distance between the underside of the Bucky cover and the top of the grid was varied as follows: 0.6, 0.9, 1.2, and 2.5 cm. ($\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, and 1 in.). The exposure and developing technic were uniform throughout the series of films. A black mask with a small window was prepared, to aid in making the readings. To read results the slit window was placed over the open end of the wire shadow on the film, and

was moved toward the closed end until the black line between the wires could no longer be distinguished and the shadows of the two wires fused into one. This level is read by counting the centimeter and millimeter notches of the opaque brass scale.

RESULTS

The readings of the scale are tabulated to illustrate the effect of increasing the distance between the object and grid while keep-

ing the amount and type of scattering material constant. It will be observed that there is very little difference to be found whether wood or bakelite is used for the cover or top of the diaphragm, provided the distance remains the same. When the grid level is lowered in respect to the cover, changes in definition become obvious. Thus, increasing the distance only 0.6 cm. ($\frac{1}{4}$ of an inch) causes a marked loss in definition. This is a small amount to allow for mobile diaphragm

TABLE I

Effect on definition produced by converting a diaphragm of the fixed type to one of the mobile type (with and without elevating device).

The figures in the body of the table indicate the finest mesh screen, the pattern of which can be resolved by the eye (the screens being numbered from the coarse end of the series)

Distance of Test Object above Bottom of Water Phantom (cm.)	Without Fluorescent Screens			With Fluorescent Screens		
	Bakelite Top	Wood Top without Elevation	Wood Top with Elevation	Bakelite Top	Wood Top without Elevation	Wood Top with Elevation
00	6	5	6	4	4	4
25	6*	5*	6*	4	3	4
50	5	4	5*	4	4	4

*Pattern made out poorly.

TABLE II

Changes in definition produced by altering the distance between the diaphragm cover and the grid level

The figures in the body of the table represent the readings of the opaque scale of the improvised test object.

Distance of Test Object above Bottom of Water Phantom (cm)	Usual Bakelite Cover	Wood Top $\frac{1}{4}$ in 06 cm	Wood Top $\frac{3}{8}$ in 09 cm.	Wood Top $\frac{1}{2}$ in 12 cm.	Wood Top 1 in 25 cm.	Wood Top Using Elevating Device
0	14	39	46	58	80	15
5*	15	21	29	34	40	16
Object-grid (top)* Distance (cm)	13	195	225	26	384	15
Object-film* Distance (cm)	30	365	395	43	554	32

*The angle between the wires was increased for this test in order to obtain readable results at this increased object distance.

*Distances given in the lower rows were obtained with the object at the bottom of the water phantom. Add 5 cm to each to obtain distances when the object is elevated in the phantom

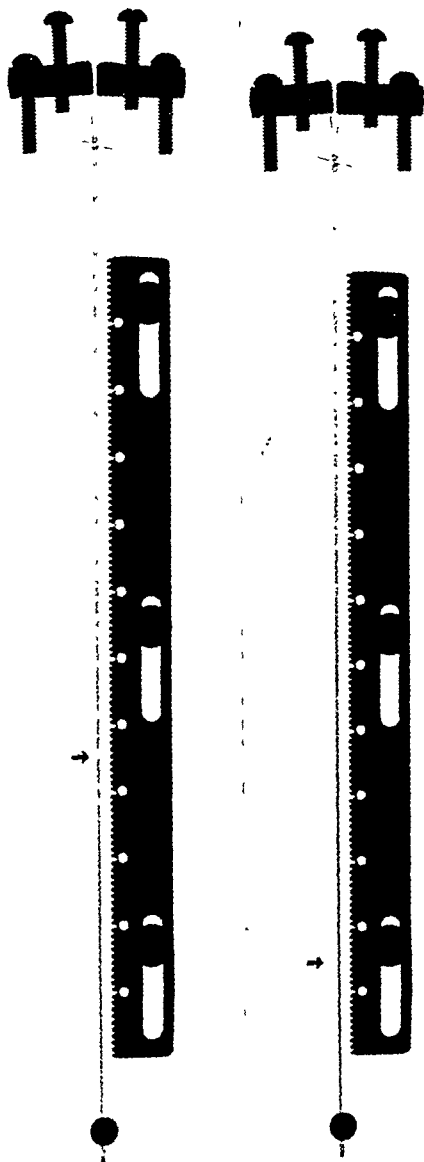


Fig. 6. Radiographs of test object with scale. The one on the left represents the result obtained when $\frac{3}{8}$ inch was allowed between the underside of the cover of the diaphragm and the level of the housing of the diaphragm. An arrow has been placed at the point (4.6) at which the reading was made (point when shadows of the two wires fused). When this distance of $\frac{3}{8}$ inch was eliminated by elevating the diaphragm against the underside of the table top, a reading of 1.5 (note arrow level of right radiograph) was possible. In other words, by elevating the diaphragm, the shadows of the two individual wires could be resolved by the eye as separate wires 3.1 cm. farther along their course.

due to the sag in the table top under heavy weight. It will be noted that, while the bakelite in close contact with the diaphragm housing, a reading of 1.4 is obtained, but when the distance is increased 0.6 cm. ($\frac{1}{4}$ of an inch), the reading on the scale jumps to 3.9. At 0.9 cm. ($\frac{3}{8}$ of an inch) a further decrease in definition becomes obvious with a reading of 4.6 (Fig. 6). This is approximately the distance between the table top and the diaphragm in our table when the elevating device is not used. It becomes imperative, therefore, to eliminate the space between the underside of the table and the top margins of the diaphragm housing. This is best done by elevating the diaphragm against the underside of the table. This, in fact, not only eliminates the space between the table top and the housing, but actually gets rid of the sag produced by superincumbent weight. A reading of the scale, obtained after the use of the elevating device, is practically the same that is found when the usual bakelite cover is used (Fig. 6). The slight difference observed is probably due to the fact that the wooden table top is 1.5 mm. thicker than the bakelite cover. Had we obtained one of the same thickness as the bakelite, identical results would probably have resulted.

Another series of films were obtained under similar circumstances, except for the position of the test object, which was elevated 5 cm. in the water phantom. This change has a marked effect on definition, and the separation of the wires was increased at the "open end" in order to permit satisfactory reading of the scale. The same type of result was obtained. Increasing the distance between the table top and the diaphragm had a deleterious effect on definition. This could be eliminated by the use of the elevating device.

For convenience, the distances between the table top and grid, the object and grid, and the object and film, are listed in Table II.

The target-film distance was kept constant at 76 centimeters (30 inches).

SUMMARY AND CONCLUSIONS

The harmful effects of increasing the object-grid distance on definition have been demonstrated by means of several different test objects. These results would indicate that the increased space between the object and grid, allowed for a mobile Potter-Bucky diaphragm, produces a very definite

and considerable effect on definition. These deleterious effects can be avoided through the use of a simple elevating mechanism. The employment of this device, in connection with the diaphragm without the cover, permits results which are practically identical with those obtained with the usual "fixed" diaphragm with a bakelite cover.

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- (1) WILSEY, R. B.: The Efficiency of the Bucky Diaphragm Principle. *Am. Jour. Roentgenol.*, 1922, IX, 58.

THE ROENTGENOLOGIC DIFFERENTIATION OF LESIONS OF THE RIGHT AND LEFT HEART¹

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IN the development of the roentgen examination of the heart, the accurate determination of the size of the organ has been chiefly considered. The differentiation of the normal from the abnormal heart by the increase in transverse diameter, surface area, or volume, as demonstrated in the teleoroentgenogram, or orthodiagram, has been well established.

Much less attention has been given to the increases in size, which may take place in individual chambers. While changes in the shape of the heart shadow have been widely used to determine the exact nature of the defect which is present, these have been chiefly studied in the postero-anterior projection. Lateral views which might demonstrate enlargement of the posterior chambers of the heart, the left atrium, and left ventricle, have been less emphasized, chiefly, no doubt, because of the difficulty in interpretation.

Cardiac disease, with or without failure, may, for certain purposes, be classified in two broad groups: left heart lesions and

right heart lesions. The former are by far the more numerous and include essentially the defects of the valves of the left heart, the aortic and mitral, and the cardiac enlargements which result from increased blood pressure. With a few rare exceptions, the diseases of the left heart are acquired lesions. It is true that mitral valvular disease affects the right heart early in its career, but the lesion originates on the left side and is properly classified as such. Right heart lesions are less common and more heterogeneous. They include disease of the pulmonic and tricuspid valves, either congenital or acquired, other congenital defects, and right heart enlargements from diseases of the lungs or of the pulmonary vessels. Such pulmonary conditions as pneumonococcosis, asthma, emphysema, and chronic lung fibrosis may produce sufficient obstruction in the pulmonary circulation to cause hypertrophy and dilatation of the right ventricle and right auricle, with eventual right heart failure. Likewise, primary disease of the pulmonary vessels, sclerosis, and, possibly, hypertension may eventuate in the same situation. It is a common feature of all these

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Fig. 1-A (left). Postero-anterior teleoroentgenogram in a proved case of mitral stenosis. Note the very small "drop" heart with no evidence whatever of any abnormality.



Fig 1-B (right) The same case, lateral view. There is a distinct, although slight, displacement of the esophagus in the region of the left atrium, indicating some enlargement of this chamber and suggesting a diagnosis of mitral disease, in spite of the negative postero-anterior view.

diseases that the enlargement is confined to the right side of the heart, the left being rarely, if ever, affected, even late in the disease.

Ordinarily, the distinction between those lesions which primarily affect the left ventricle, such as aortic valvular disease and hypertension, and diseases of the right heart is comparatively simple, both clinically and roentgenologically. The physical findings and the postero-anterior roentgenograms are very different in the two cases.

In mitral disease, however, this differentiation is often difficult. That this is true can be borne out by anyone who has examined many cases of cardiac disease in children, in whom congenital defects are so common. The recent paper of Seham, Shapiro, and Hilbert (7) gives abundant evidence of this difficulty, especially in the early stages of the disease. A report of some cases by the author (3) presents a good pic-

ture of the difference of opinion which may occur amongst cardiologists when problems of this type come up. It is not surprising that this should be so. In many cases murmurs are atypical, the percussion dullness in the two types of heart may be much the same, and the history may be misleading.

Roentgenologically also, the distinction is often difficult to make. Particularly in children is this true because the enlargement of the right ventricle, which occurs in mitral stenosis, may simulate closely the appearance of a congenital cardiac defect. While in the majority of right heart lesions the postero-anterior roentgenogram may show striking differences from that of mitral stenosis, in many cases this difference is not reliable. Both groups of cases produce enlargement of the right ventricle and dilatation of the conus arteriosus and of the pulmonary artery. Usually, in congenital defects the latter is a more prominent feature



Fig. 2-A (left). Postero-anterior roentgenogram in a case of double mitral valvular disease in a child. The shape of the heart strongly resembles that found with congenital defects, such as patency of the ductus arteriosus. Note the compression and displacement of the esophagus to the right, which frequently occurs in mitral disease.



Fig. 2-B (right). The same case, lateral view. Note the marked posterior displacement and compression of the esophagus in the region of the left atrium. The retro-esophageal space is obliterated from the seventh to the ninth thoracic vertebrae. The appearance is typical of mitral valvular disease with enlargement of the left atrium. This diagnosis was made in spite of the postero-anterior appearance.

and the absence of the curve of the appendage of the left atrium may help to rule out mitral disease, but this also is of value only in the late stages.

From the standpoint of the pathologic physiology of the heart, one of the most essential differences between these two groups of cases lies in the presence or absence of enlargement of the left atrium. It is always enlarged in mitral disease with symptoms of cardiac embarrassment; in right heart lesions it is never enlarged. This difference is inherent in the very nature of the lesions which are present. The first effect of mitral stenosis upon the heart is left atrial hypertrophy and dilatation. In the case of mitral insufficiency, the left ventricle may possibly be affected first to a slight degree, but the left atrium follows shortly. If the teleroentgenogram evidences a definite enlargement of the heart due to mitral disease, the left atrium must then also be en-

larged. If the patient is presenting any symptoms of cardiac failure—no matter how slight—due to mitral disease, enlargement of the left atrium must already have taken place. In the right heart lesions, the whole process takes place on the other side of the pulmonary circulation and the left atrium is usually undisturbed.

The demonstration of an enlarged left atrium in this differentiation is, therefore, of considerable importance. There is another group in which it is of great value: those individuals without organic heart disease who have symptoms which simulate cardiac failure, who often have a systolic murmur at the apex, and in whom in some cases, the teleroentgenogram suggests the appearance of a mitral heart. Usually the size is well within normal limits, but the contour may resemble that of mitral stenosis. With the knowledge that mitral stenosis often does not produce marked cardiac en-



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Fig 1-B (right) The same case, lateral view. There is a distinct, although slight, displacement of the esophagus in the region of the left atrium, indicating some enlargement of this chamber and suggesting a diagnosis of mitral disease, in spite of the negative postero-anterior view.

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Fig. 4-A (*left*). Postero-anterior teleoroentgenogram in a massively enlarged heart of congenital origin.



Fig. 4-B (*right*). Same case, lateral view. There is little or no displacement of the esophagus, indicating that the enlargement shown in Figure 4-A is entirely right-sided. Such a large heart, if it were of mitral origin, would produce an extreme posterior displacement of the esophagus.

scribed by the author (4) and many others (1, 2, 5, 6, 8) is an effective and comparatively accurate method. The close relationship of the esophagus to the left atrium (which, considering its actual position, would better be called the posterior atrium) is well shown in the lateral view. Compression and displacement of the esophagus posteriorly and to the right occurs at an early stage in the enlargement of this chamber. If the proper technic is used, this displacement, in most cases, is readily seen, and is simulated only by a few, easily demonstrable conditions. In our experience, and in that of others (7) this method has been highly successful, both in the distinction of right and left heart lesions and in the separation of functional from organic cardiac disorders. The author has reported three striking cases illustrating the increased accuracy in cardiac diagnosis which is obtained in this way (3). Many other cases of a similar nature have since been observed.

The detailed technic of the examination and the normal and pathologic findings have been previously reported (4). The normal appearance of the esophagus after the in-

gestion of several ounces of very thick barium sulphate paste is seen in Figures 3-A and 3-B. The postero-anterior view (Fig. 3-A) presents a straight tube indented slightly by the aortic arch and curving to the left at the diaphragm. The right lateral view (Fig. 3-B), made during deep inspiration, presents a slightly curved tube, the convexity being posterior and the inferior portion curving anteriorly at the diaphragm. This view is made with the patient in the true lateral position, the right side being against the film. There is a definite distance of as much as 2 centimeters between the spine and the esophagus. In functional cardiac conditions, the esophageal findings may be much the same, although the postero-anterior view often resembles the configuration of mitral disease. In certain mild grades of mitral stenosis, the postero-anterior view may not be entirely characteristic, as illustrated by the case shown in Figure 1-A, and there may be no enlargement whatever of the transverse diameter of the heart.



Fig 3-A (left) Postero-anterior roentgenogram in a case of right heart enlargement of undetermined origin. There were no clinical signs whatever of valvular heart disease. There is absence of any esophageal displacement. This is the typical normal appearance. Note the resemblance of this heart to the one shown in Figure 1-A.

Fig 3-B (right) Same case, lateral view. There is no displacement of the esophagus, indicating that the enlargement is essentially of the right heart. Note the difference in appearance from the case shown in Figure 1-B.

largement, that diagnosis is often made. The situation described above may occur in the presence of a perfectly normal heart, as has often been demonstrated in the past. Many a normal individual, who is eventually proven to have no heart disease, has been refused life insurance and been greatly restricted in his activities because he happened to have such a combination of symptoms and signs. Every roentgenologist is familiar with these cases in which one sees a very marked convexity of the left median curve without enlargement of the transverse diameter or the surface area of the heart.

In this group, too, the determination of whether or not the left atrium is enlarged is of vital importance. The absence of de-

monstrable enlargement, while it would not rule out mitral disease, would indicate definitely that the apparent symptoms of cardiac embarrassment could not be due to myocardial failure of mitral origin. On the other hand, if the left auricle is shown to be enlarged, the diagnosis of mitral disease is definitely clinched.

Lateral examination of the thorax with the roentgenoscope or by the roentgenogram may demonstrate enlargement of the left atrium, but the results are difficult to interpret. The left atrium may be simulated by many structures which lie lateral to it and the vague shadow obtained is frequently not convincing. The utilization of the barium-filled esophagus for this purpose as de-

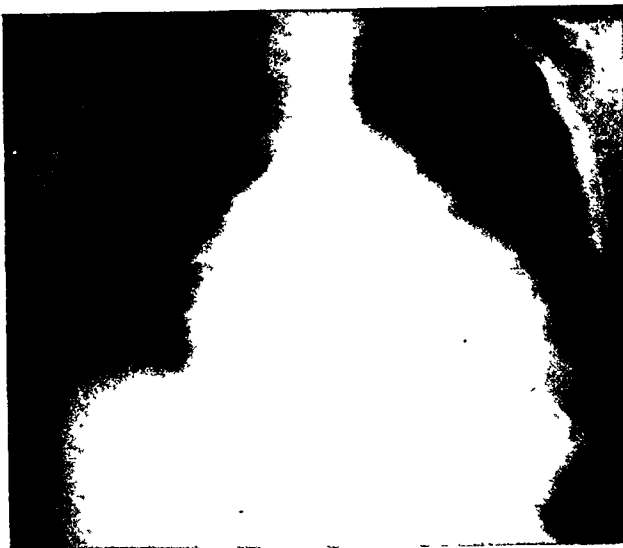


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From this film alone the diagnosis of cardiac disease could hardly be made. The right lateral view of the esophagus (Fig. 1-B) may, however, demonstrate clearly a slight posterior displacement in the region of the left auricle, helping greatly to confirm the clinical diagnosis of mitral disease. In the more advanced cases of cardiac enlargement from mitral disease, the compression and displacement of the esophagus are much more obvious, definite displacement to the right being shown in the postero-anterior view (Fig. 2-A) and toward the spine, in the lateral view (Fig. 2-B).

Occasionally, true cases of mitral disease, in children particularly, may simulate the appearance of a congenital defect in the postero-anterior view. This is well illustrated in Figure 2-A, from a well established case of mitral stenosis and regurgitation. The high position of the convexity on the left is strongly suggestive of a congenitally defective heart. Nevertheless, definite displacement of the esophagus to the right and posteriorly (Fig. 2-B) is well shown, establishing the presence of a dilated left atrium, hence the diagnosis of mitral disease.

Diseases of the pulmonary circulation, whether due to sclerosis, possible hypertension, or changes in the lung parenchyma itself, may give the appearance illustrated in Figures 3-A and 3-B. The first clinical diagnosis in this case was mitral stenosis and regurgitation. The postero-anterior view (Fig. 3-A) resembles either the cardiac configuration resulting from mitral disease or from a congenital defect. It could be considered as a fairly good example of the former, resembling quite closely the appearance shown in Figure 2-A. However, in the right lateral view (Fig. 3-B), there is no displacement whatever of the esophagus indicating that the lesion must be affecting the right heart exclusively, and, therefore, could not be due to mitral disease. Eventually, this case was shown to be of pulmonary origin with no valvular lesion whatever, the dis-

ease being confined to the pulmonary circulation.

Congenital defects may give much the same findings as illustrated in Figures 3-A and 3-B. Occasionally, combined congenital defects produce a very marked cardiac enlargement such as is shown in Figure 4-A. This would be very difficult to interpret by itself as the appearance might easily be produced by combined lesions of both the mitral and aortic valves. The absence of displacement of the esophagus in the lateral view (Fig. 4-B) effectively demonstrates that there is no enlargement of the left atrium. In the presence of such a large heart, mitral disease would thus be definitely ruled out; aortic disease alone could hardly be considered with such a postero-anterior configuration; hence a right heart lesion, probably congenital in origin, would be the logical diagnosis and this is clearly borne out by the clinical findings.

There are, obviously, certain inherent errors in the use of this method. In cases of marked kyphosis of the thoracic spine, for example, the space between the esophagus and the spine may be still present, even though the esophagus has been posteriorly displaced by an enlarged left atrium, the kyphosis compensating for the displacement. The contrary is true in lordosis of the thoracic spine, in which this space may be obliterated even in the presence of a normal heart. A lengthened, ectatic, descending aorta may retract the esophagus posteriorly, itself giving the appearance of displacement by an enlarged heart. In such a case, the lack of a dense shadow anterior to the esophagus, and the displacement of the esophagus to the left in the postero-anterior view, instead of to the right as is usual in mitral disease, helps to rule out this displacement. Occasionally, a displacement is seen in diffuse cardiac dilatations, such as occur with pericarditis, the toxic or fibrotic myocardium, and in the late stages of hypertension or aortic valvular disease. In these

cases, however, while the distinction from mitral disease may be somewhat difficult, there is usually no doubt that the heart is not normal and that it is not a right heart lesion. A complete absence of displacement of the esophagus may occur in mitral disease, but only when there are no cardiac symptoms. The physical findings which identify the condition in such cases are obtained accidentally, or during the course of a routine examination. Such a lesion is usually of little or no clinical significance.

In spite of these inexactitudes, intelligent application of this technic and intelligent interpretation of the roentgenoscopic and roentgenographic findings will prove to be an invaluable aid in the accurate differentiation of functional heart conditions and right heart lesions from the cardiac enlargement originating in disease of the mitral valve.

SUMMARY

1. The clinical differentiation of lesions exclusively causing enlargement of the right heart from mitral valvular disease is often most difficult. The postero-anterior roentgenograms may be of little value in some cases.

2. Certain functional cardiac conditions may simulate mitral valvular disease clinically. In these, the postero-anterior roentgenogram may resemble that seen in mitral disease.

3. The examination of the barium-filled esophagus may be a great aid in this distinction. Very early in the course of cardiac enlargement of mitral origin, posterior and often right-sided displacement of the esophagus occurs, due to the enlargement of the left atrium.

4. This displacement does not occur in the other two types of cases, because either there is no cardiac enlargement at all, or else the right side alone is affected, the left atrium remaining normal.

5. This method of distinction has been

used in many difficult cases with striking success.

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DISCUSSION

DR. FRED J. HODGES (Ann Arbor, Michigan): Dr. Rigler has emphasized the importance of examining the heart itself by a similar routine procedure, giving proper weight to recognizable changes in the size, shape, and position of various portions of the cardiac shadow as seen in various views. He has shown, furthermore, that, as a result of thoroughgoing study, information can be gained which compares favorably in value with information obtained by ordinary methods of physical examination, and that the roentgenologist is fully justified in drawing clinical conclusions from his observations.

We have all heard cardiologists question the roentgenologist's right to diagnose roentgenographically a valvular lesion. Many clinicians feel that roentgenology has contributed but little to cardiac diagnosis. I feel that we have been shown that the roentgenologist can, in many cases, offer valuable clinical information based upon variations in appearance, which in turn have a sound physiologic basis. We have seen that many of these observations are fully as reliable as the recognition of a typical cardiac murmur. As a group, we roentgenologists have long been content to make somewhat off-hand comments concerning the probability of cardiac or vascular damage, without making a serious or detailed study of the heart and great vessels. If we were to accord to this field the

same careful attention to routine and detail which has come to be accepted for roentgen examination of the urinary tract, the paranasal sinuses, and the chest, I feel sure that the value of the roentgen findings in cardiovascular disease would be more widely accepted by cardiologists. Careful fluoroscopic study of the chest, including orthodiagraphic plotting of the cardiac silhouette, examination in various oblique views, observations of the contour and course of the esophagus when it is filled with barium, together with film studies as indicated by fluoroscopic appearance, should be the routine employed by the roentgenologist in every case in which cardiovascular disease is suspected.

DR. L. R. SANTE (St. Louis, Mo.): Dr. Rigler's paper is an example of the application of practical observation in radiology. Analysis of the situation, not only in this but in other fields, might aid us a great deal in understanding our observations. The findings Dr. Rigler has demonstrated are really what you would expect, and the changes he has shown are really the changes that you would expect to see, but he has shown them in a very graphic way.

In a rather recent development of synchronization of roentgenograms with the heart beat by means of an electrocardiograph, setting off the x-ray apparatus in extreme systole and diastole of the heart, an instantaneous record of the cardiac outline during the extremes of contraction and relaxation is obtained.

This seems to me to be of great fundamental value. For instance, by the calculation of the heart volume for extreme systole and extreme diastole, the output per beat can be calculated, which is, after all, the basis for determining cardiac function.

Knowing the output per beat, the way is opened for determining what effect certain drugs have upon the heart and circulation. It seems to me that such investigation would be of fundamental importance. It is by no means a simple procedure; it requires special apparatus and special painstaking methods. It is not yet ready for the general radiologic department.

DR. DREW LUTEN (St. Louis, Mo.): An intensive study of any diagnostic procedure, such as Dr. Rigler has given to the problem that he presented so clearly, has a twofold value. It improves the technic of the test and makes it more valuable in differential diagnosis. Sometimes, more important still, it leads to a better understanding of the disease process under investigation. The conception, to which Dr. Rigler refers several times, of enlargement of the left auricle with heart failure would appear to give important support to the notion that ventricular failure is associated essentially with inability of the ventricle to deliver the blood that is supplied to it.

There is still some discussion as to ventricular output in heart failure. Dr. Rigler's observation would appear to support the conception that there is a relative, if not an absolute, diminution of output and an inability to deliver the blood that is supplied from above.

The same underlying factor would appear to be associated with right ventricular failure, even though the disease process responsible for that failure depends ultimately upon different causes. I was rather interested to note that Dr. Rigler included among those lesions which cause right heart disease such processes as bronchial asthma and emphysema. It is Kountz and Alexander's belief that bronchial asthma and emphysema do not produce right heart disease, their ideas being supported both by theoretic considerations and by postmortem findings.

In a clinical study of the hearts of asthmatic patients, we found no increased incidence of heart disease. The finding of right axis deviation in the electro-cardiogram, which has been reported in support of right heart disease in such cases, can hardly be interpreted as an evidence of right heart disease, because the electrical axis commonly deviates to the right in that position of the heart assumed with the associated emphysema.

The question of whether or not bronchial asthma and emphysema are important causes of right heart disease, however, is not an integral part of Dr. Rigler's paper. If I may,

for just a moment, I will refer to the remarks of your chairman that roentgenographic observations of the heart are equal in importance to clinical observations, a conception which cannot be controverted. Certainly the radiologist should have only thanks for the knowledge he gives. The work Dr. Rigler has done must indeed, in many instances, be of very great help in differential diagnosis.

DR. SAMUEL BROWN (Cincinnati, Ohio): The determination of the correct size of the heart for the particular individual under examination has always been a difficult problem for me to decide. The several factors given by the speakers, upon which the determination of the correct size of the heart is made, are, in my opinion, too variable under normal conditions to depend upon, and they may lead one to incorrect conclusions.

In my work I have found that there exists one factor which is constant under normal conditions: the constancy of the relationship between the heart and aorta and the thoracic cage. When the heart is enlarged, or the thoracic aorta is dilated, the relationship is immediately disturbed. This disturbance in relationship is easy to recognize both in the anterior and the lateral views of the thorax.

DR. RIGLER (closing): I just want to cor-

rect a false impression which I gave. I did not mean to associate the left atrium as a causative or etiologic factor with heart failure. I have not the temerity to rush in and discuss whether the atrium or the ventricle is associated with failure. I meant only to point out that, in the stage of cardiac disease which we have when failure occurs, there must already be an enlargement of the left atrium. I did not mean to say that it is an important part of failure. I have no opinion on that question.

Likewise, I have no opinion on the question of asthma as a cause of right heart disease. I merely mentioned it because it is a common conception. I certainly do have an opinion that chronic lung disease with marked fibrous change will create heart enlargement. There are many pathologists who thoroughly believe that emphysema and asthma are related to right heart failure.

DR. HODGES (closing): To correct any misapprehension on Dr. Luten's part concerning present relationships between roentgenologists and cardiologists, I wish to assure him that I feel any criticism we may have received in the past has been entirely justified. Haphazard roentgen examination of the heart and great vessels has led to a lack of confidence on the part of clinicians in such studies. This state of affairs can and should be corrected.

IODIZED RAPESEED OIL (CAMPIODOL), AN IMPROVED ROENTGENOGRAPHIC OPAQUE OIL¹

By MARK ALBERT GLASER, M.D., LOS ANGELES, and
GEORGE W. RAIZISS, PH.D., PHILADELPHIA

FOLLOWING the experimental introduction of campiodol (Frazier and Glaser, 1; Glaser, 2), it immediately became apparent that an iodized oil most efficient for the visualization of the various body cavities should have physical proper-

ties adaptable for each individual cavity. This led to the synthesis of dilution products as well as an emulsion.

Undiluted campiodol is best used to outline the tracheobronchial tree. The dilution of campiodol with ethyl olive oil resulted in a free-flowing, less viscous compound, which still retained sufficient opacity

¹Read before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, December 1-5, 1930.

for roentgenographic visualization. Equal parts of campidol and ethyl olive oil were ideal for the visualization of the nasal sinuses; whereas a 4-to-1 dilution was invaluable for the outline of the subarachnoid

valence linkage of the carbon atom. The iodization of rapeseed oil was accomplished by utilizing a variation of the methods of Hubl wherein mercuric chloride is used as a catalyst. This method of iodization has

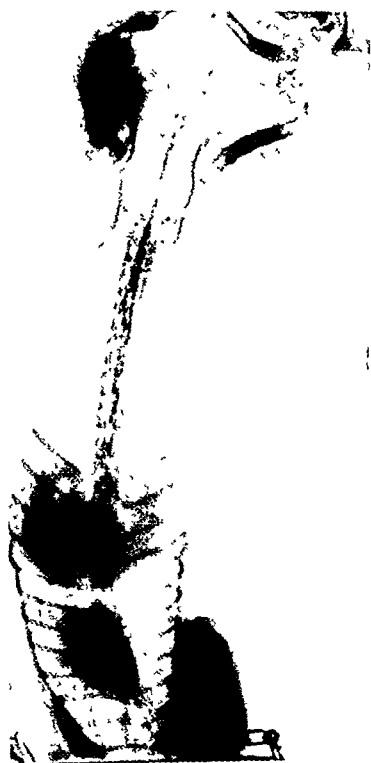


Fig. 1.



Fig 2

space, the blood vessels, fistulae, uterus, and salpinx. In order to visualize the genitourinary tract, an emulsion of campidol proved the most satisfactory and has been utilized successfully in over 500 cases.

The ability of certain oils to absorb iodine depends on the unsaturated property of some of the carbon atoms composing the glyceryl esters present in the oils. These unsaturated glyceryl fatty esters vary in their degrees of iodine absorption, and those with the highest amount of unsaturation will naturally absorb the largest amount of iodine. The iodine will be held in firm union once it has combined with the free

been described elsewhere (Raiziss, Glaser, and Clemence, 3).²

Rapeseed oil (colsa oil), which proved to be the most satisfactory for iodization purposes, is derived from the seeds of *Brassica napus*, *Brassica campestris*, *Brassica rapa*. It is a yellow, almost odorless oil with a specific gravity of 0.914 and an iodine value of 93.5 to 105.6. It is composed of the glycerides of stearic, erucic, and an oleic acid.

Iodized rapeseed oil (campidol) is a light yellowish, semi-viscous, transparent oil

²The author has included citations from the literature subsequent to the reading of his paper.

with a slightly aromatic odor and oleaginous taste. It contains from 43 to 45 per cent iodine and its specific gravity is from 1.2 to 1.3 at 20° centigrade. It is soluble in chloroform, ether, benzene, and carbon bisulphide, and insoluble in water and alcohol. This chemical compound deteriorates very slowly upon exposure to light and heat, some samples remaining stable for over a year, with which, upon radiographic exposure, an intense shadow is obtained.

Campiodol (rapeseed oil) is an oil of very low toxicity. Given by mouth, dogs have withstood 6.75 c.c. per kilogram of body weight without toxic effects. Injected into the internal carotid artery, with ligation of the external carotid, the dogs were able to withstand 1.5 c.c. per kilogram of body weight. Six c.c. of oil have been injected into the subarachnoid space by cisternal injection in dogs weighing from 4 to 5 kilograms, without toxic effects. Spinal-fluid-cell counts on dogs wherein 2 c.c. of iodized oil have been injected by cisternal puncture varied from 250 to 600 cells per c.c. between the first and second days. At the end of five or six days, the cell count ranged between 5 and 15 cells per cubic centimeter. In clinical cases of hydrocephalus 7 c.c. of the oil were injected into the ventricles with a maximum count of 310 cells per c.c. on the second day.

For use in the spinal subarachnoid space, 4-to-1 iodized rapeseed oil is an ideal product because of its free-flowing qualities and low viscosity. Campiodol may be injected through a small caliber needle either in the lumbar region or in the cisterna. By elevating or lowering the head of the patient, as well as placing him on his back or abdomen, its flow may be observed under the fluoroscope. In this manner partial or complete spinal block may be determined.

Iodized rapeseed oil should not be indiscriminately used and should not be used as a routine. Great care should be taken in the selection of the proper cases. Its use is



Fig. 3.

particularly indicated in those cases wherein a level lesion is present upon clinical examination, and the jugular compression test demonstrates the absence of blocks, or in those cases wherein a level lesion is absent and the jugular compression test indicates presence of a partial or complete block. In suspected cases of tumor of the cauda equina, campiodol is of great value. An oil of a specific gravity lighter than the spinal fluid is undesirable in the demonstration of spinal block because violent reactions occur, such as high temperature, convulsions, and increased cell count (Figs. 1 and 2).

The cerebral vascular system has been outlined by the injection of the internal carotid, with ligation of the external carotid (Fig. 3). So far this has been used only in dogs. Moniz (4) with sodium bromide, and more recently Saito, Kamikawa, and Yanagizawa (5 and 6), with an emulsion of iodized oil, have successfully outlined the cerebral vascular system.

Rice (7), in a personal communication to the authors, has reported the use of campiodol in nine cases of peripheral vascular lesions. He prefers the 50 per cent mixture because it is of the same specific gravity as blood. In this manner he is certain about accurately determining the venous flow.

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²The author has included citations from the literature subsequent to the reading of his paper

Kutzmann, 10). Emulsification has permitted the oil to mix with the urine in the kidney pelvis and because of this slight viscousness, reflux into the bladder has been prevented. By its use pain, burning, and other signs of discomfort have been eliminated because of the inertness of the product. Cystograms and urethrograms may also be obtained with much ease. The syringe method has been utilized in these cases because of the slight viscousness of the emulsion. Dr. A. A. Kutzmann (11) has used this product in over 500 cases without any toxic effects and with a maximum relief of symptoms.

Dr. M. J. Abramson has utilized this produce in a 4-to-1 dilution in uterosalpingography without any toxic effects and without pain. A 4-to-1 solution has proved of unusual value for the outline of the body sinuses.

For the outlining of sinuses, a 4-to-1 dilution is quite satisfactory and clear visualization is obtained.

CONCLUSIONS

1. Iodized rapeseed oil, campiodol, because of its various products designed particularly for the different body cavities, is of great value for roentgenologic visualization.

2. It has been used in the subarachnoid space, cerebral ventricles, vascular system, nasal sinuses, the tracheobronchial tree, male

and female genito-urinary tracts, and fistulae without toxic effects and with an ease of administration and maximum of visualization.

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CASE REPORTS AND NEW DEVICES

AN INTERESTING CASE OF OSTEOCHONDROMA

By LESTER J. WILLIAMS, M.D., F.A.C.R.,
BATON ROUGE, LA.

In the past few years a marked advancement has been made in the diagnosis and treatment of bone tumors. The interesting and educational Bone Tumor Clinic of Dr.

Bloodgood and Dr. Geschickter, as well as the appointment of a Registry Committee by the American College of Surgeons to study and classify bone tumors, have contributed in a large measure to a better understanding of the value of early diagnosis of bone tumors.

Many of the benign bone tumors are re-



Fig. 4.

Ten c.c. of campidol were injected into the blood stream without symptoms (Fig. 4).

Campidol is also of value in demonstrating the patency of the vessels as well as accurately localizing the area of obstruction.

Iodized rapeseed oil is of great aid in the accurate diagnosis of chest pathology, particularly in those patients complaining of persistent cough, expectoration, hemoptysis, or chest pains in the absence of tubercle bacilli. It is contra-indicated only in those cases wherein the oil will lower the vital capacity below that of normal. Dr. William B. Faulkner, Jr. (8), has found that the catheter method of injection gives more consistent results. Campidol is introduced under the fluoroscope so that its flow may be visualized through the bronchi, the x-ray plates being taken immediately. In those cases wherein a bronchus was occluded by pus, a foreign body, or tumor, preliminary bronchoscopy was necessary to clear the pathway.

For the diagnosis of bronchiectasis

campidol has been of extreme importance to demonstrate the extent and location of the process. Frequently cases of bronchiectasis can be diagnosed only by this method. In empyema, campidol is of value to determine the degree of lung expansion, and in this manner further treatment may be prescribed, particularly in those cases of closed drainage. Chronic abscesses of the lung can readily be filled with campidol. Acute lung abscesses can be visualized only if the obstructed bronchus is treated preliminarily by the bronchoscope. This clears the bronchus of pus, granulation tissue, or edema. In some cases of lung disease a definite therapeutic value has been noted.

Fifty per cent of campidol and 50 per cent of ethyl olive oil has proved most satisfactory for outlining the maxillary sinus. Due to its diminished shadow-casting property, the essential soft tissues may be clearly outlined and because of its low viscosity special syringes are unnecessary. Iodized rapeseed oil has proved of great value in determining the exact thickness of the mucous membrane and in the diagnosis of polyps and cysts, also for the clearing up of antrums wherein the density was due to increased bone or unerupted teeth. By determining the exact thickness of the antrum wall a more exact prognosis can be offered the patient and the indication for medical or surgical treatment may be more accurately determined. The frontal sinuses may also be outlined.

To overcome the objections of many observers who have been unable to tell when the antrum is filled completely, thus frequently advising operation on antrums without thickened walls, a series of head positions have been devised so all the walls of the antrum may clearly be visualized, the shift of the oil in the sinus permitting such observations (Glaser, Futch, and Snure, 9).

In urography, emulsified iodized rapeseed oil has proved satisfactory (Glaser and

Present Illness or Complaint.—About five years previous to the present examination the patient noticed a swelling of the left ankle. He thought nothing of it until the summer of the fifth year when it became larger, causing a deformity above the external malleolus. He also noticed that the left knee was smaller than the right. There was no pain, and he was able to play tennis and exercise regularly without difficulty.

X-ray Examination.—An osteochondroma of the left tibia was seen, measuring approximately 3.5 by 4 cm. and located on the outer posterior surface about 5 cm. above the ankle joint. The left fibula near the site of the enchondroma of the tibia exhibited a deformity from pressure of the benign growth.

The most striking thing in the roentgenogram of this case is the appearance of erosion of the fibula, with only a thin cortex remaining as a result of continued pressure. Incidentally, the fibula is regarded as one of the strongest bones in the body. The pressure of the osteochondroma of the tibia against the fibula has caused a bowing outward of the latter bone, amounting to 2 centimeters. One would imagine that this bone, instead of gracefully retreating with the formation of this symmetrical arch, would have halted and diverted the tumor enemy army.

In his work on "Bone Formation," Jansen gives us some illuminating information about bony tissue which shows "a natural liability to absorption, a tendency to yield, with regard to lateral pressure of softer neighboring structures." He states as axiomatic that the vertebræ will stand 2 kg. pressure per sq. cm., in the direction of pressure for which the bone is built, but if the pressure is applied at right-angles, only one-eighth of this amount is necessary for rapid destruction of bony tissue.

REDUCTION OF FRACTURES AND REMOVAL OF FOREIGN BODIES

USING OIL-IMMERSED SHOCK-PROOF UNITS, BI-PLANE FLUOROSCOPY, AND SPECIAL FRACTURE DEVICE

By LEX G. McCUTCHEN, M.D., Department of Radiology, St. Louis University and St. Louis County Hospital

There is a growing demand for the separate fracture room in the x-ray department. That this room should be equipped with modern x-ray and fracture facilities goes without saying. In the writer's experience in x-ray and fracture work, he has found that the oil-immersed tube, the bi-plane fluoroscopic screen, and a simple mechanical means of extension should be available units of these facilities.

Since the introduction of the oil-immersed tube, it has been a relatively simple matter to have a fracture room that is free from the dangers of electrical shock—an advantage which can best be appreciated by those who have worked in the darkness of the old-time fluoroscopic room, with its hazardous overhead wires.

The safety of the oil-immersed tube has also been an advantage in bringing about the use of the bi-plane fluoroscopic screen, which has been found practical and exceedingly helpful both in fracture work and in the removal of foreign bodies. The lateral view afforded by the bi-plane is a great time-saver, as it serves as an *instant* check on the accuracy of the anteroposterior view. The two views of the bi-plane can now be conveniently controlled by two foot switches incorporated in a block, together with the light button (Fig. 2). Using this method of control, it is possible for the operator to shift instantly from the anteroposterior view to the lateral, and *vice versa*, or to turn on the light in the room without shifting his position. Radiographs may also be made in two views without moving the pa-

garded as being incapable of producing harmful effects other than a slight discomfort and, at times, slight pain. For this reason these tumors are permitted to progress, without attention, until such serious

In presenting this case of osteochondroma, I appreciate that it is a manifestation of a not uncommon disease with which every roentgenologist is familiar. The case is interesting and instructive because it demon-



Fig 1

complications arise as to demand immediate attention. It is a wise physician who makes frequent use of the roentgen ray in observing the progress of benign bone tumors for possible complications, such as malignancy, also their encroachment upon vital structures, and marked destruction of adjacent bones.

Osteochondroma, considered one of the benign tumors, on account of its usually mild symptoms and frequent occurrence, often evades clinical observation.

strates that a so-called innocent benign tumor, such as an osteochondroma, is capable of producing serious results so insidiously as to be unobserved except by the roentgen ray.

Case B. F. B., male, aged 19, weight 129 pounds, height 72 inches. Family history: Mother, 50 years of age, living and well; father died at the age of 55; cause of death, nephritis. No history of rickets or skeletal deformities in the family, nor was there any history of tuberculosis or cancer.

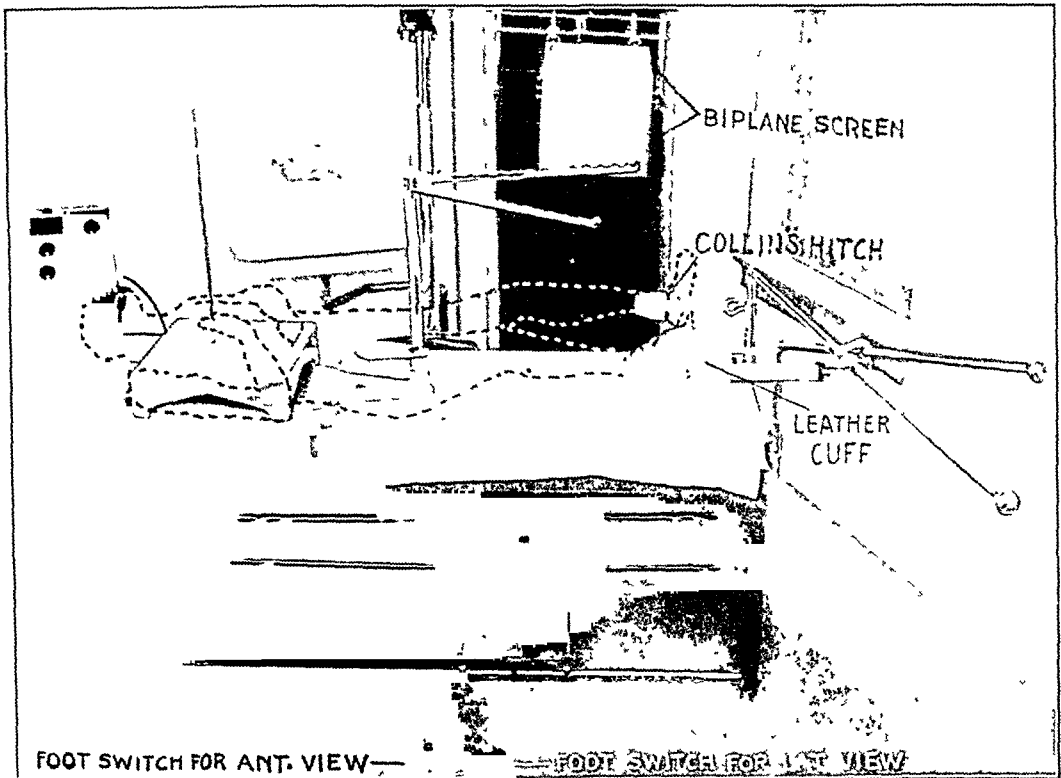


Fig. 2 Fracture device on x-ray table with bi plane screen and shock-proof oil-immersed unit.

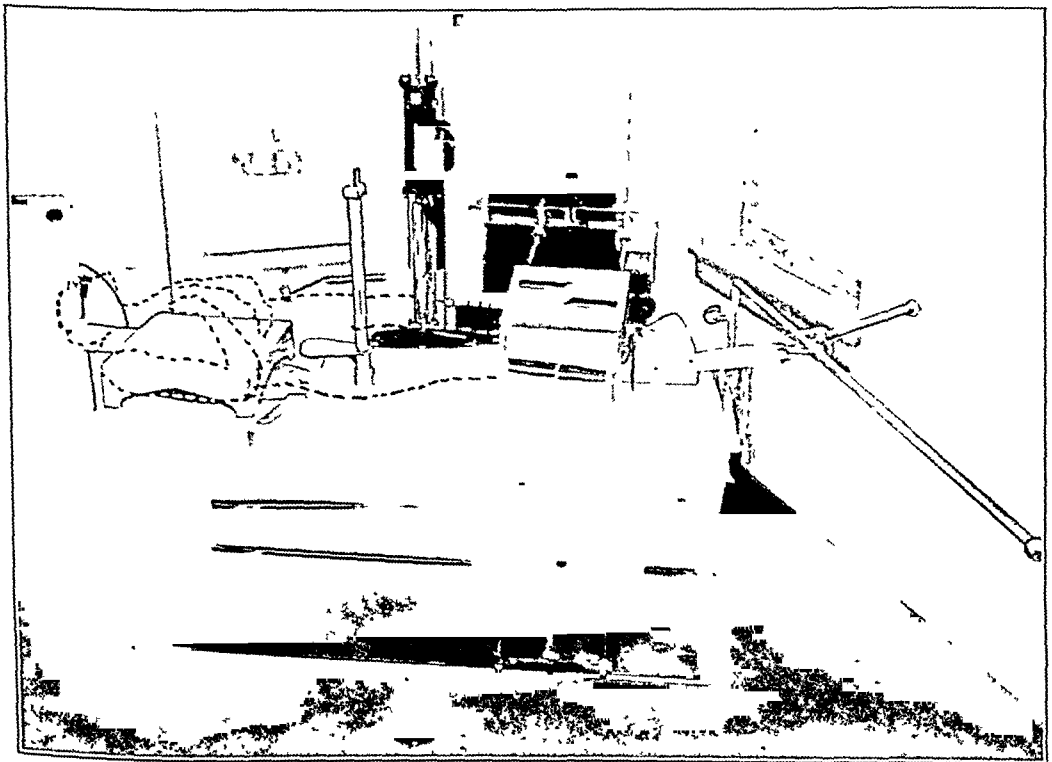


Fig 3 Lower extremity fracture using fracture device, bi-plane screen, and shock-proof oil-immersed unit.

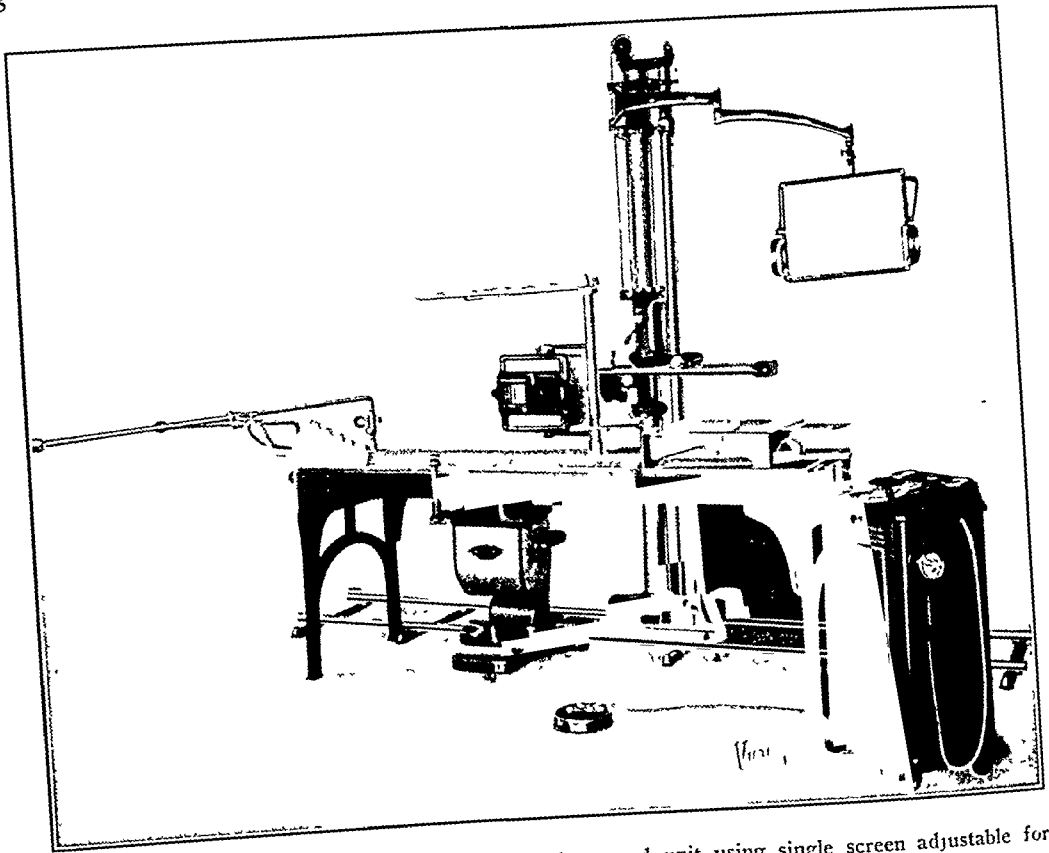


Fig. 1. Fracture device and shock-proof oil-immersed unit using single screen adjustable for anteroposterior and lateral views.

tient or changing the setting on the control stand. This combination switch has been in use for some time and it has proved very satisfactory.

The fracture apparatus illustrated was devised some years ago by the writer for use in conjunction with the fluoroscope. Since the first publication describing it, several improvements suggested by its use have been made, although the general structure of the apparatus has remained the same. Its efficiency has been greatly increased since the advent of the oil-immersed tube, as the reduction of fractures in the x-ray room prior to this was greatly hampered by the dangers of overhead wiring. It saves time, energy, and unnecessary handling of the patient, as the fracture may be reduced, the

cast applied, and the radiograph made on the x-ray table. Another advantage lies in the fact that it is portable. It may be taken to the operating room to provide extension during open reduction and its attachment or detachment is extremely simple. When it is removed from the table, the fracture room, equipped with oil-immersed tube and bi-plane fluoroscope, becomes an ideal foreign body room.

In the reduction of fractures of the upper extremity, the patient is placed at right angles to the table, with the standard in the axilla or against the chest wall (Fig. 4). By using the long lever under the control of bi-plane fluoroscopy, the fragments of broken bone can be manipulated. After reduction, steady extension may be main-

EDITORIAL

LEON J. MENVILLE, M.D. Editor
BUNDY ALLEN, M.D. Associate Editor

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A LIST OF POSSIBLE VARIABLES FOR RAY EFFECT INVESTI- GATIONS

Scientists hold the most optimistic views concerning the possibilities which lie in the field of x-ray and related ray applications. This is true of workers in fields which are widely separated. H. J. Muller,¹ of the University of Texas, for instance, stated of his field, genetics, that x-rays are means by which we may be able to regulate life itself. His statement has to do with the kinds of modifications which we may make in genes and chromosomes. A. H. Compton is quoted as stating that if the voltage of x-ray tubes can be raised to between ten and twenty million, the door to the release of atomic energy may be opened.

It is the purpose of the following list to name the conditions which may be varied in either the tube, the ray, the surrounding spaces, or in the treated material itself during such fundamental investigations of ray effects. An attempt has been made to imagine all of the possible variables of possible significance, but no claim is made, of course, that it is complete. Nevertheless, it is believed that a great deal of the future sciences of genetics, ray chemistry, and ray physics, as well as future x-ray machine design, must be erected within the framework here indicated. At best, however, the aid will be merely such as the armchair philos-

opher can give the real investigator. The writer would be glad to hear of additions to the list which others may make, and suggests that some scientific librarian take the subject in hand to give the variables library index numbers in the same way that radio literature has been codified. An enormous ray effect literature already exists. The list, proceeding from the obvious variables to the obscure ones, is as follows:

- Vary the identity of the material rayed.
- Vary distance from ray source.
- Vary time of treatment.
- Vary number of treatments.
- Vary voltage of tube, *i.e.*, hardness of ray.
- Vary milliamperage of tube, *i.e.*, quantity of ray.
- Vary target temperature.
- Vary target material: (a) metals; (b) non-metals; (c) mixtures or compounds.
- Vary filament temperature.
- Vary filament area.
- Vary filament material.
- Feed tube alternating current: (a) vary wave shape.
- Feed tube direct current: (a) vary current, as pulsating.
- Control electron flow in tube with grid: (a) modulate ejected x-rays.
- Control character of radiation by magnetic field (Faraday effect).
- Control character of radiation by electrostatic field.
- Control character of radiation by filter: (a) liquids; (b) solids; (c) solutions; (d) thickness; (e) angle.
- Vary character of secondary radiation in subject by first injecting secondary x-ray generating material.
- Vary character of x-rays by mixing with

¹Heredity Variations. Their Production by X-rays and Their Relation to Evolution. Smithsonian Rep. for 1920, pp. 345-362; also Scientific Monthly, December, 1929.

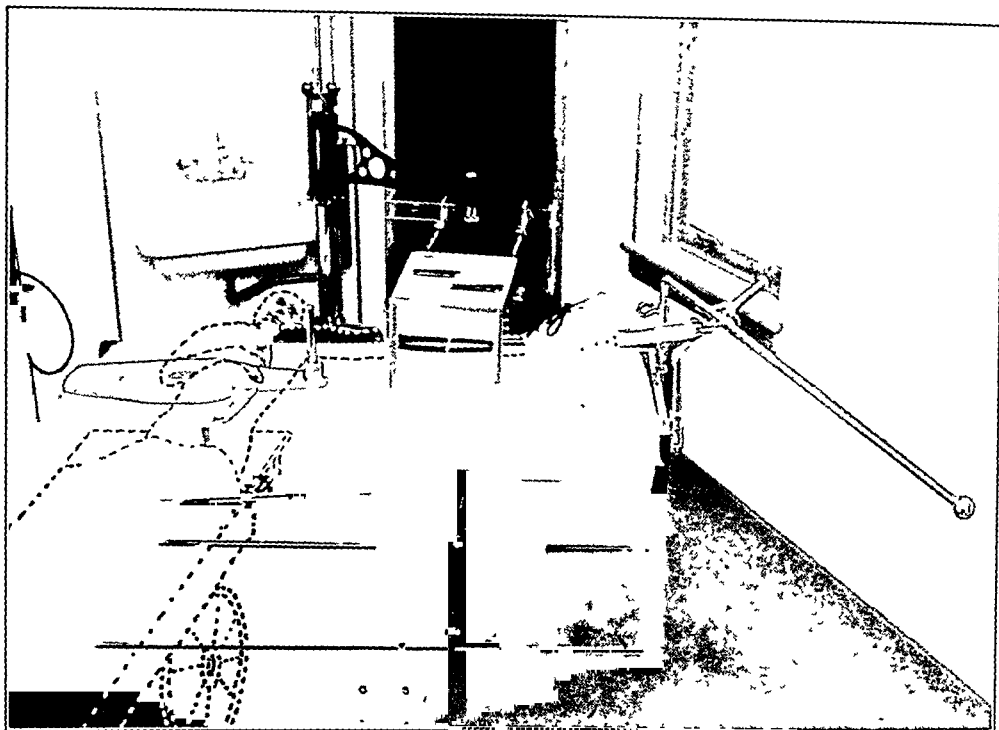


Fig. 4 Upper extremity fracture; traction at right-angle to body, with bi-plane fluoroscopic control and shock-proof oil-immersed unit.

tained and x-ray films made in two views without changing the position of the fractured extremity.

In the reduction of fractures of the surgical neck of the humerus, the leather cuff can be adjusted along the lever until the fragments are in good alignment when viewed under the fluoroscope. Adequate traction is available.

In the reduction of lower extremity fractures, the patient is anesthetized on the stretcher, then lifted to the table and placed on the pelvic support, back and head rest. The extremity is wrapped in sheet cotton or encased in stockinet. A Collins' hitch of three-inch muslin bandage is then tied to the ankle. The leather cuff is applied over the

hitch (using three eyelets). After the necessary extension has been obtained, radiographs are made in two views without changing the position of the patient or the setting on the control stand of the x-ray machine.

Removal of the leather cuff without releasing extension is very simple. The ends of the Collins' hitch are tied to hook on the long traction bar. This maintains extension after the cuff is removed. The hitch may be incorporated in the cast or removed after the cast is applied.

The writer has found the combination described to be helpful and it is his belief that it will prove a valuable as well as an attractive addition to an x-ray department.

EDITORIAL

LEON J. MENVILLE, M.D. *Editor*
BUNDY ALLEN, M.D. *Associate Editor*

*Contents of RADIOLOGY copyrighted by the
Radiological Society of North America.*

A LIST OF POSSIBLE VARIABLES FOR RAY EFFECT INVESTI- GATIONS

Scientists hold the most optimistic views concerning the possibilities which lie in the field of x-ray and related ray applications. This is true of workers in fields which are widely separated. H. J. Muller,¹ of the University of Texas, for instance, stated of his field, genetics, that x-rays are means by which we may be able to regulate life itself. His statement has to do with the kinds of modifications which we may make in genes and chromosomes. A. H. Compton is quoted as stating that if the voltage of x-ray tubes can be raised to between ten and twenty million, the door to the release of atomic energy may be opened.

It is the purpose of the following list to name the conditions which may be varied in either the tube, the ray, the surrounding spaces, or in the treated material itself during such fundamental investigations of ray effects. An attempt has been made to imagine all of the possible variables of possible significance, but no claim is made, of course, that it is complete. Nevertheless, it is believed that a great deal of the future sciences of genetics, ray chemistry, and ray physics, as well as future x-ray machine design, must be erected within the framework here indicated. At best, however, the aid will be merely such as the armchair philos-

opher can give the real investigator. The writer would be glad to hear of additions to the list which others may make, and suggests that some scientific librarian take the subject in hand to give the variables library index numbers in the same way that radio literature has been codified. An enormous ray effect literature already exists. The list, proceeding from the obvious variables to the obscure ones, is as follows:

- Vary the identity of the material rayed.
- Vary distance from ray source.
- Vary time of treatment.
- Vary number of treatments.
- Vary voltage of tube, *i.e.*, hardness of ray.
- Vary milliamperage of tube, *i.e.*, quantity of ray.
- Vary target temperature.
- Vary target material: (a) metals; (b) non-metals; (c) mixtures or compounds.
- Vary filament temperature.
- Vary filament area.
- Vary filament material.
- Feed tube alternating current: (a) vary wave shape.
- Feed tube direct current: (a) vary current, as pulsating.
- Control electron flow in tube with grid: (a) modulate ejected x-rays.
- Control character of radiation by magnetic field (Faraday effect).
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- Control character of radiation by filter: (a) liquids; (b) solids; (c) solutions; (d) thickness; (e) angle.
- Vary character of secondary radiation in subject by first injecting secondary x-ray generating material.
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other radiation, such as radium, ultra-violet, etc., of selected wave length.

Vary polarization of x-rays themselves.

Vary polarization of admixed ray.

Vary temperature at which treatment is given.

Vary pressure at which treatment is given.

Vary gases of atmosphere in which treatment is given.

Vary kind of cells to which treatment is given (by shielding selected portions).

Vary age of cells to which treatment is given.

Vary pH of cells to which treatment is given (acidity or alkalinity).

Vary humidity of atmosphere at which treatment is given.

Vary water content of cells to which treatment is given.

Vary work done by cells before treatment is given.

Vary work done by cells after treatment is given.

Vary food supply of cells before treatment is given.

Vary food supply of cells after treatment is given.

Vary number of sources of x-rays acting at one time.

Vary angles at which such sources act.

Vary amount of hormone stimulation of cells before, during, or after treatment.

Vary degree of dispersion of material before treatment.

Vary electrical grounding of material to which treatment is given.

Vary electrostatic charge of material to which treatment is given.

Vary current flowing through subject.

Vary direction of current flowing through subject.

Vary type of current flowing through subject.

Vary number of components of system being rayed.

Vary phases of components being rayed.

Vary phase incidence of rays from two or more sources in the material itself.

Use secondary radiation exclusively.

Use reflected radiation, as from crystal surfaces.

Vary magnetic influences on subject being rayed.

Vary order of raying of parts or components of subject.

Vary kind of mechanical stresses on subject being rayed.

Vary value of mechanical stresses on subject being rayed.

Vary the raying of food supply of subject.

It is plain that after varying the above factors one at a time, they may then be varied two at a time and so on. In this way compound effects may be produced. Since the number of combinations thus contemplated approximates infinity, a statement of the "alphabet" upon which they are based may be of value. While predictions are hazardous, it would seem as if important biological effects, at least those tending to advance the specialization of species, would not flow from the variation of a single factor.

As Baekeland said of our laboratory chemistry compared to that of life processes, it is like trying to play the piano by exploding a dynamite cartridge between the strings. Such a statement is equally true as to the biological effects of our present methods of raying.

To use a different figure of speech, the x-ray is capable of becoming a sculptor's tool in the hands of the biologist and geneticist. Hitherto, it has been only, in therapy, a means of destroying pathologically affected cells. Development would, therefore, seem to lie in the modification of its violence and in the modulation of its waves to a complexity of oscillation commensurate with the complexity of the results desired.

CHESTER TIETIG, M.S.

Covington, Ky.

COMMUNICATIONS

A LETTER OF PROTEST

In the *Journal of the American Medical Association*, May 6, 1933, appeared an editorial entitled "Disturbances of the Heart as Indication for Surgical Intervention in Hyperthyroidism," which appeared to the Editor of RADIOLOGY as showing such misinformation on the part of its writer that he felt constrained to voice a protest. The following letter has been sent to the Editor of the *Journal of the American Medical Association*, with the request that he publish it.

May 22, 1933

Dear Sir:

May I call to your attention certain inaccuracies which occur in your editorial on "Disturbances of the Heart as Indication for Surgical Intervention in Hyperthyroidism," appearing in the May 6, 1933, issue of the *Journal of the American Medical Association*.

The character of editorials appearing in that *Journal* has been of such high order that the countless physicians reading them are all agreed that they represent the latest and most accurate thought in the advancement of modern medicine. When we find deviation from such standards in arraigning a well known and accepted method of treatment we naturally look for an explanation in order that we may have a better understanding of the motive activating such a departure.

It would seem that our parent organization should be free from partisanship and deal alike with all of its members. It appears that this principle has not been adhered to in this editorial. There can be no denying the fact that certain physicians representing specialized branches of medicine become over-enthusiastic in regard to some method or methods of treating disease. This is true not only of radiologists but of other specialists as well. However, this cannot

apply in the instance of the treatment of thyrotoxicosis by irradiation.

The editorial begins with: "The behavior of the heart in hyperthyroidism presents a number of interesting problems for the surgeons and internists." Why not also the radiologists, who have occasion to see thousands of such cases? Is it because the writer thinks that radiologists lack sufficient knowledge to enable them to appreciate the interesting problems mentioned, and for this reason are ignored? The treatment of goiter to-day is as much a radiologic problem as it is surgical.

The editorial further states that "It seems generally agreed that the most efficient method of treating thyrotoxicosis to-day is by subtotal removal of the thyroid gland." It would be interesting to know where such information was obtained, and in what manner. There is hardly a town of any size in this country in which toxic goiter is not being treated by irradiation and in a most satisfactory manner.

The editorial contains another inaccurate statement wherein it is said that "Attempts at control of these symptoms [speaking of toxic goiter] by roentgen irradiation or by iodine therapy are, as a rule, inefficient, while valuable time is wasted and pathologic changes in the cardiovascular system progress." Again I ask how this information was obtained. Is it the reaction of an internist or surgeon? Has an honest effort been made to ascertain the status of radiology in the treatment of this disease before censuring a method of which the writer apparently knows little? For his information I give actual statistics obtained in an impartial, unbiassed, and unprejudiced manner. When surgical statistics are obtained in a similar manner there will be a change of opinion from that expressed in the editorial in question.

In the March, 1932, issue of RADIOLOGY will be found a paper on the Radiological Aspect of Thyrotoxicosis which clearly

shows a true and impartial evaluation of radiation treatment of toxic goiter. The statistics presented were obtained from radiologists of varied experience in the treatment of this disease, some reporting on as few as five cases, others on hundreds, and one on 1,500. The percentage of satisfactory results was least in the instance of radiologists treating small numbers of cases and highest among those treating large numbers of cases, but to render a fair and unbiased report the general average was taken. This showed a percentage of cures of 66.22; marked improvement in 21.07; recurrence in 8.45; failure in 12.4. I am quite sure that the percentage of cures compares favorably with that of surgery if a study be made of the surgical cures reported by general surgeons and not by a few expert goiter surgeons. In this study it was also shown that, of the 10,500 cases treated by radiation, nearly 1,000 had been operated upon previously.

Another misleading statement is made in your editorial. You mentioned that it is reported that the mortality rate following surgical operation for toxic goiter is less than 1 per cent. What good news would this be to the goiter patients who contemplate surgical intervention, if only it were true! No doubt, in a few—and a very few—surgical institutions of note such a low mortality rate is correct, but only a small percentage of goiter operations the country over are done in these institutions. After all, what counts is what general surgeons are doing, not just a few clinics, though they be large. General surgeons, most capable in other surgical fields, but such as lack specialized experience in goiter surgery, show a surgical mortality which is far higher than “less than 1 per cent.” The medical profession and the public are getting tired of hearing of this “less than 1 per cent” mortality because they know better. Why not be frank with ourselves and state the true rate of mortality, as nearly as we can arrive at it?

In 1929, A. B. Cooke stated that there was a general increase in surgical mortality rates during recent years, and that thyroid surgery headed the list, with a mortality rate which had increased 250 per cent in the preceding two decades. He believed the reason for this increase to be that every local surgeon to-day operates on goiter cases, while several years ago operation was done by only a few experts. Before him, N. J. MacLean, writing in 1921, made a survey to ascertain the surgical mortality in exophthalmic goiter, sending questionnaires to 100 United States and Canadian hospitals. The replies indicated that a mortality rate of 8 per cent existed then. Some time later he sent questionnaires to 200 additional hospitals, and obtained about the same percentage, the mortality rate being then 7 per cent. There is nothing to indicate any sharp drop in the percentage since these surveys were made.

It is not my desire to undermine or to minimize the importance of surgery in the treatment of toxic goiter, but I do object to letting pass without comment an editorial distinctly and unjustly antagonistic to radiation. Also, I take exception to the fact that so little information was obtained before the *Journal* proceeded to publish an editorial against an accepted method, employed throughout the world in the treatment of toxic goiter.

Sincerely yours,

LEON J. MENVILLE, M.D.

AMERICAN CONGRESS OF RADIOLOGY

SEPTEMBER 25-30, 1933

Chicago during the World's Fair will welcome the largest radiological congress ever held in the United States when the four national radiological societies will meet there in joint convention. Other members of the medical profession are invited as well. The American Congress of Radiology is sched-

uled for September 25-30, inclusive, at the Palmer House. According to Dr. Henry K. Pancoast, of Philadelphia, President of the Congress, all physicians, physicists, biologists and others connected with the allied sciences will be made welcome at the Congress.

The four radiological societies sponsoring the Congress that have eliminated their regular annual meetings for 1933 in its favor are: The American College of Radiology, the American Radium Society, the American Roentgen Ray Society, and the Radiological Society of North America. The Chicago Roentgen Society will also participate.

Scores of visitors from Central and South American countries are expected to attend the Congress, and invitations have been sent to European colleagues. Over a hundred and fifty essayists will devote 55 full hours to the scientific program. The six-day program, however, places the scientific meetings to terminate at 2:00 P.M., leaving the afternoons free for visiting the Century of Progress World's Fair. Incidentally, the Fair itself will have remarkable worthwhile displays showing the development of the x-rays and radium in their medical applications.

Benjamin H. Orndoff, M.D., of Chicago, Chairman of the Executive Council of the Congress, invites members of the medical profession to inquire further of him by writing to 2561 N. Clark Street, Chicago, concerning membership in the Congress, railroad and hotel rates, etc. He points out that the Palmer House is reserving 1,400 rooms for the period of the Congress and guarantees that rates will not be increased or other prices advanced during the session. The Palmer House was selected for the Congress because it is so well arranged for such an event, and the scientific sessions, as well as scientific and commercial exhibits, will all be on one floor.

Numerous committees are hard at work planning the Congress. Among these are the History and Education Committee, headed

by Byron H. Jackson, M.D., of Scranton, Pa., President of the Radiological Society of North America. This committee will publish a special volume, known as "Science of Radiology," for the members of the Congress, and will sponsor an unusual exhibit of old medical texts which will trace the history of radiology from the early chemistry of the Middle Ages. Other Committees include those on Publicity, James T. Case, M.D., of Northwestern University, Chicago, Chairman; Committee on Local Arrangements, M. J. Hubeny, M.D., of Chicago, Chairman; Scientific Exhibits, B. R. Kirklin, M.D., of the Mayo Clinic, Rochester, Minn., Chairman; Scientific Program, George E. Pfahler, M.D., of Philadelphia, Chairman; Publications, Leon J. Menville, M.D., of New Orleans, and Lawrence Reynolds, M.D., of Detroit, Co-chairmen; Committee on Photography, A. U. Desjardins, M.D., of the Mayo Clinic, Rochester, Minn., Chairman; Commercial Exhibits, John T. Murphy, M.D., of Toledo, Ohio, Chairman; Finance, E. L. Jenkinson, M.D., of Chicago, Chairman; Travel and Transportation, Henry Schmitz, M.D., of Chicago, Chairman; Membership, Albert Soiland, M.D., of Los Angeles, Chairman.

The President of the Congress is Henry K. Pancoast, M.D., of Philadelphia. The Vice-presidents are: Albert Soiland, M.D., of Los Angeles, as President of the American College of Radiology; Burton J. Lee, M.D., of New York, as President of the American Radium Society; John T. Murphy, M.D., of Toledo, Ohio, as president of the American Roentgen Ray Society, and Byron H. Jackson, M.D., of Scranton, Pa., as President of the Radiological Society of North America. The other officers are: Chairman of the Executive Council, B. H. Orndoff, M.D., of Chicago; Secretary of the Council, E. L. Jenkinson, M.D., of Northwestern University, Chicago; Treasurer of the Council, Henry Schmitz, M.D., of Loyola University, Chi-

cago. The Executive Council, aside from the names just given, includes the chairmen of the various committees.

JAMES T. CASE, M.D., *Chairman*
Publicity Committee.

DR. ALBAN KÖHLER HONORED



During the meeting of the German Roentgen Society which took place in Bremen, April 22-24, the Rieder Gold Medal was awarded to Dr. Alban Köhler, of Wiesbaden, for outstanding work in roentgenology. This honor has been

awarded to the late Guido Holzknecht, of Vienna, and to Gösta Forssell, of Stockholm.

The Radiological Society of North America offers its congratulations to Dr. Köhler, who is teacher and friend to many of our members.

ANNOUNCEMENT

At the request of James T. Case, M.D., the following notice is published.

The Reunion of French Language Physicians practising radiology and electrology (Medecins Electroradiologistes de Langue Française), under the auspices of the Société Française d'Electroradiologie et de Radiologie medicales, of the Société de Radiologie medicale française and of the Société Belge de Radiologie, to which are invited French-speaking physicians of whatever nationality, will be held in Paris, Oct. 12, 1933, at the Faculty of Medicine at the same time as the Congress of Surgery.

The following questions will be the order of the day:

1. The radiological examination of the mucosa of the large intestine. Reporters: Dr. Ledoux-Lebard, chief of service of medical electroradiology to the Hospitals of Paris, and Dr. Gilbert, medical radiologist of the Cantonal Hospital of Geneva.

2. The short waves. Reporter: Professor Rechou, of Bordeaux, assisted by Dr. Auclair, Dr. Dausset, and Dr. Droust.

The officers of the Congress are as follows: Dr. Belot, *President*; Dr. Delherm, Dr. Rechou, and Dr. Dubois-Trepagne, *Vice-presidents*; Dr. Dariaux and Dr. Portret, *Secretaries*; Dr. Morel-Kahn, *Treasurer*.

BOOK REVIEWS

THE PELVIS IN OBSTETRICS. A Practical Manual of Pelvimetry and Cephalometry, Including Chapters on Roentgenological Measurement. JULIUS JARCHO, M.D., F.A.C.S., Consulting Roentgenologist, Hastings Hillside Hospital; Attending Obstetrician and Gynecologist, Sydenham Hospital. A volume of 365 pages, 140 illustrations, and 51 tables. Published by Paul B. Hoeber, Inc., New York, 1933. Price \$6 00.

This volume, a good example of the publisher's art, is printed on good quality paper using large, easily legible type; the illustrations are profuse and well-made and convey an excellent first impression. The value of this book, however, lies not in any original material, for no pretense of novelty is made, but in a compilation of rather widespread data, so that its significance is more as a basis for future analysis and comparison of pelvic measurements than in its immediate practical application.

Virtually every possible manual and caliper measurement that has ever been made is well described, portrayed, and evaluated. The tables of racial variation in pelvic size should prove of special interest to practitioners who find

themselves in contact with a varied racial element among their patients.

The chapter on x-ray pelvimetry is clearly written. Perhaps too much is made of the various "different" methods which in the end resolve themselves into but two, the stereoscopic triangulation and the target-film over object-film proportion types. However, these are well described and are undoubtedly of considerable value.

The chapter on cephalometry is likewise well done. Whether more mention of the difficulties of determining the exact sites of the fetal head *in utero*, and of maintaining them while exposures are being made, should not have been made, is open to question.

The bibliography is excellent and should make it practically unnecessary to go back beyond this time to cover the literature in this field. It shows a careful search of past endeavors. The book, as a whole, should prove of widespread interest, although to the well-posted radiologist it offers little save a compilation of data; that alone, however, should make it worthy of a place in his library.

EINFÜHRUNG IN DIE RÖNTGENOLOGIE. A Text-book for Physicians and Students. G. F. HAENISCH, Prof. Dr. Med., Leitender Oberarzt am Allgem. Krankenhaus Barmbeck, Hamburg, and H. HOLTHUSEN, Prof. Dr. Med., Leitender Oberarzt am Allgem. Krankenhaus St. Georg, Hamburg. With a physical-technical introduction by A. LIECHTI, Priv.-Doz. Dr. Med. Chefarzt am Inselspital, Bern. A volume of 359 pages and 299 illustrations and drawings. Published by Georg Thieme, Leipzig, 1933. Price, 25 marks.

As indicated in the title, this is an introduction to roentgenology, so the material has been contracted down to the point where it can be assimilated readily by students or physicians without previous training in roentgenology.

As is usual in the publications of this house, the printing and illustrations are beautifully done. The diagrams are numerous and clarifying. While the section on physics and technic,

comprising about 44 pages, is complete, it seems more elaborated than necessary for a student's textbook. It may be criticized because so little attention is paid to roentgenographic technic, an important feature of the student's training.

The section on diagnosis, written by Dr. Haenisch, is notable for its clarity of language, which makes it easy reading for the non-German student. The general statement of the principles of roentgen diagnosis is unusually good and is well worth study even by specialists in the field. Furthermore, the detailed analysis of roentgenograms of several different portions of the body represents a fine achievement in demonstrating the fundamentals of roentgen diagnosis. The general *critique* of the value and limitations of the roentgen method, while rather conservative, is very well written.

The specific details of regional diagnosis are, however, briefly done. The whole section comprises only about 150 pages, so there is little room for detail. This is perhaps justifiable in this type of text, but there would seem to be a marked disproportion in an allocation of space which gives the therapeutic and physics sections of a textbook for general practitioners much more space than that assigned to the diagnostic section. The latter will inevitably be much more used. Notable omissions, due undoubtedly to the need for brevity, are encountered.

The section on roentgen therapy was written by Prof. Holthusen. On the whole, the treatment of the subject is excellent, the broad discussions of the effects of radiation on cells being particularly commendable. In the detailed discussion of the treatment of specific diseases, the book suffers from a tendency to include too many diseases in which the effects of radiation are most questionable. American readers may be particularly surprised to find pernicious anemia, gonorrhea, hemophilia, and abscesses of teeth, to mention only a few, discussed at some length as proper cases for roentgen therapy. Nevertheless, this section is well worth the perusal of the specialist in radiology, as well as the student.

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J. E. Habbe, M.D.	Davis H. Pardoll, M.D.
E. T. Leddy, M.D.	E. A. Pohle, M.D., Ph.D.

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BLOOD CHANGES

Changes in the Blood Picture after Roentgen Deep Therapy and Their Prognostic Value. Hans Bosch. *Strahlentherapie*, 1932, XLV, 503-524.

The author states that four factors usually produce changes in the blood picture in carcinoma patients following roentgentherapy: (1) the irradiation itself; (2) the indirect effect on the bone marrow; (3) the toxins produced by tumor necrosis; (4) the bacterial infection of the tumor.

The prognosis is, as a rule, favorable if there is only a slight drop of hemoglobin and erythrocytes, a decrease of the leukocytes immediately after the exposure which returns to normal within from eight to twelve weeks, a small drop in lymphocytes, a slight increase in polynuclear cells and eosinophils, and a drop of the monocytes and mast-cells. The opposite reaction of the blood must be considered as an unfavorable prognostic sign. The author emphasizes that one single factor should not be regarded as significant.

ERNST A. POHLE, M.D., Ph.D.

CONTRAST MEDIA

Radiography of the Placenta and its Possible Clinical Applications. Domenico Vajano. *Archivio di Radiologia*, Sept.-Dec., 1932, p. 773-788.

The author carried out radiologic and histologic experiments on rabbits and guinea pigs and showed that it is possible to visualize the placenta

by a single non-toxic intravenous or intracardiac dose of colloidal thorium (thorotrast) which is harmless to the fetus and to the mother. He, therefore, feels that the method may be worthy of a clinical trial.

E. T. LEDDY, M.D.

THE DIAPHRAGM

Examination of the Action of the Diaphragm in Hiccup by Means of Phrenography. Giovanni Paltrinieri. *Rivista di radiologia e fisica medica*, December, 1932, IV, 645-768.

The author studied two cases of hiccup, one of so-called paradoxical hiccup, by Palmieri's technic of phrenography (a simplified method of cinematography for the study of movement of the diaphragm, described in 1922). The study of his cases, illustrated by 15 figures in the paper, considers some of the findings which are of importance in the examination of the diaphragmatic function in normal and pathologic lesions.

E. T. LEDDY, M.D.

EXPERIMENTAL STUDIES

The Tissue Cultures in Plasma of Animals Exposed to Roentgen Rays. A. Calò. *Strahlentherapie*, 1932, XLV, 487-502.

Cultures of embryonal heart and spleen were grown in the plasma of chickens which had received

DIE CURIE-RÖNTGENTHERAPIE BÖSARTIGER FRAULEIDEN (Curie-roentgentherapy of Malignant Disease in Women). By DR. STEFAN SIMON, Leiter der Strahlenabteilung der 1. Universitäts-Frauenklinik in Wien. Radiologische Praktika, XX. A volume of 122 pages and 78 illustrations. Published by Georg Thieme, Leipzig, Germany, 1933. Price, 13.20 marks.

In the introduction the author emphasizes the fact that although radiation therapy has many remarkable results to its credit, it must still be considered in its infancy. The proper application of radiant energy requires many years of specialized study and training in order that one may avoid the dangers connected with its use.

The book offers a precise and comprehensive outline of the present status of x-ray and radium therapy in the treatment of malignant tumors located in the female generative organs. In a general part the essentials of a proper preparation of the patient for the treatment are related, followed by a description of the technic of administering radium and x-rays. The biologic effect of radiation on normal and pathologic tissue is also dealt with briefly.

In the special part we find the various tumors discussed, arranged according to their location: cancer of the vulva, of the vagina, of the cervix uteri, of the corpus uteri. The carcinomatous blastoma in the ovary and the sarcoma of the generative organs are also mentioned. For each group the following points are discussed: clinical experience, structure of tumor, subdivisions, indications and contra-indications for radiation; the radical, prophylactic, and palliative treatment; treatment methods used as adjuncts, the after-care, prognosis, and statistical results.

Numerous well-chosen illustrations accompany the text, a good percentage of these being devoted to diagrams of radium applicators *in situ*. The radiologist who has a reading knowledge of German will be well rewarded for the time spent with the study of this monograph.

LES ABCÈS DU POUMON (Pulmonary Abscess). By M. LÉON KINDBERG, Médecin des Hôpitaux de Paris, and ROBERT MONOD, Chirurgien des Hôpitaux de Paris, with the collaboration of A. SOULAS, Assistant d'O. R. L. à l'Hôpital Laënnec. A volume of 322 pages and 119 illustrations. Published by Masson et Cie., Paris, 1932. Price, 55 francs.

An internist and a surgeon, assisted by an otolaryngologist, have joined forces to write a comprehensive clinical study of the pulmonary abscess. The material is grouped under the following headings: general introduction, pathologic anatomy, etiology, clinical features, complications, diagnosis, various types of treatments (medical, bronchoscopic, surgical). In a concluding chapter the experience of the authors is critically analyzed, and definite therapeutic indications, based on their observations, are given for the various types of patients and pathologic processes. The text is profusely illustrated by more than a hundred roentgenograms and an extensive bibliography will be found at the end of the book. This monograph should appeal to the radiologist as well as to his confrères in the medical profession.

ROENTGENSTEREOSCOPY IN DENTISTRY. By Privatdozent DR. J. v. RECKOW, Marburg. Vol. LXXXIII of "Deutsche Zahnheilkunde," 1933, with 80 pages and 21 illustrations. Published by Georg Thieme, Leipzig, Germany. Price, 6 marks.

The author reviews at great length the various stereoscopic methods, particularly regarding their application on dental problems. He then reports his own studies leading to certain conclusions as to the scope of roentgenstereoscopy in dentistry. If the distance between skull and film is 2 meters (teleostereoradiography), the whole skull can be taken on a relatively small film. Intra-oral stereoscopic films are indicated if two films, taken in different planes, are not sufficient to enable one to arrive at a diagnosis.

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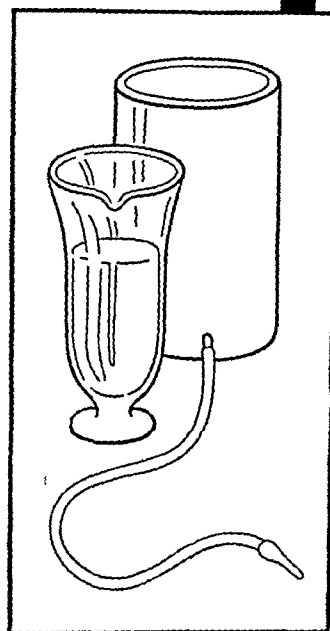
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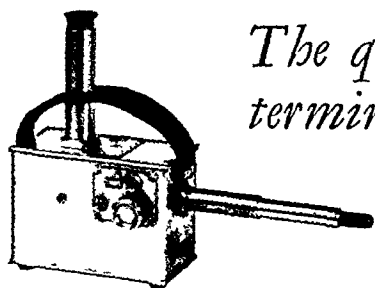
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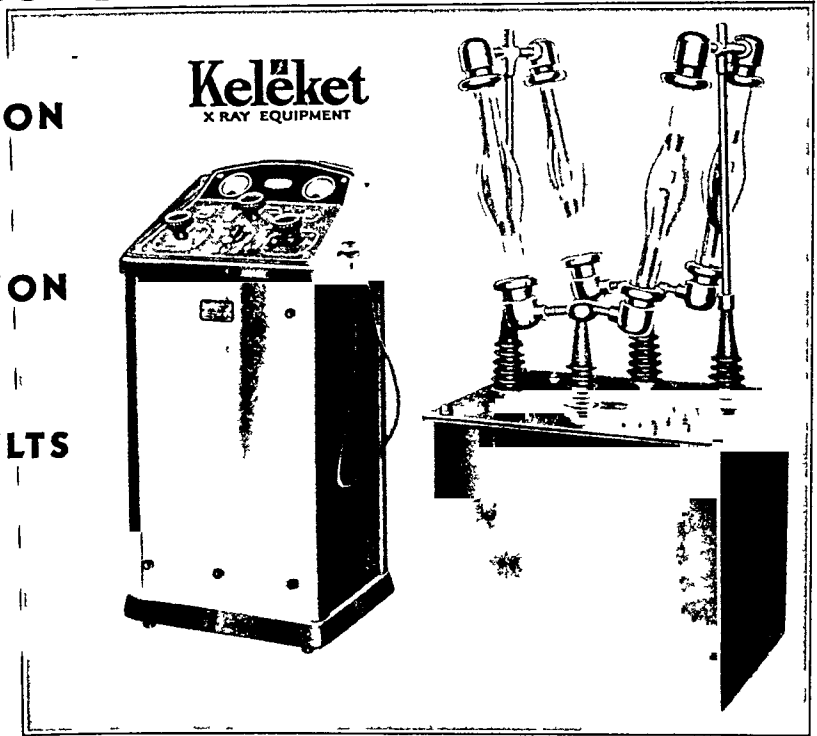
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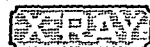
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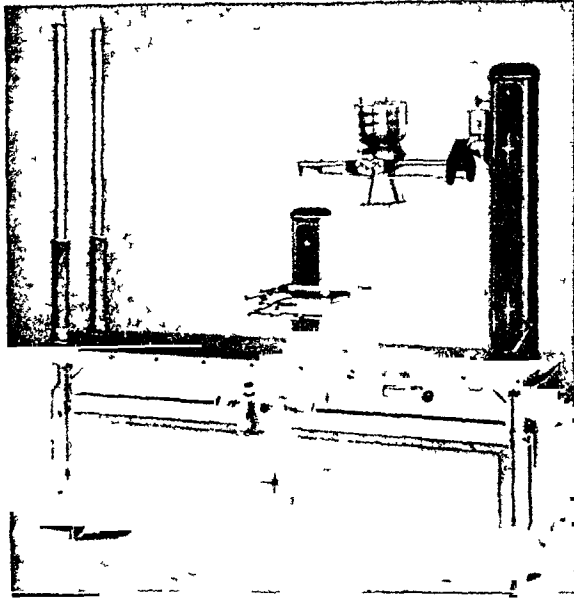
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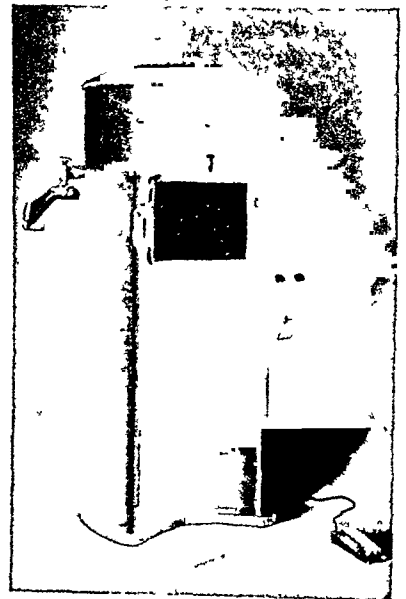
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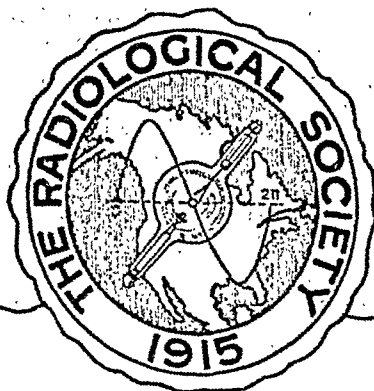
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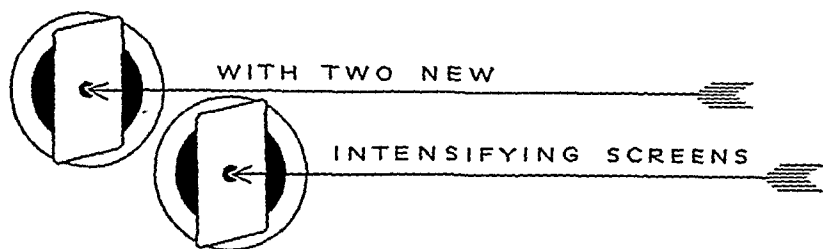
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Volume XX

Number 4

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A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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VOL. XX

APRIL, 1933

No. 4

OSSEOUS DEVELOPMENT AS AN INDEX OF METABOLISM¹

By E. KOST SHELTON, M.D., SANTA BARBARA, CALIFORNIA

THERE was a time when clinical medicine paved the way for biochemical research: of late years the reverse has been true. The laboratory, long looked upon as merely an adjunct in the elucidation of disease, now assumes an importance second to none. The change came about through the gradual recognition that a living organism is essentially a biochemical machine. Man is no exception. This tardy discovery opened new avenues of thought and brought to light many new and hitherto unsuspected disorders. As a consequence, medicine is, at present, in a state of flux.

It has not been long since metabolic disorders went undiagnosed, even in *extremis*. At present, many are unrecognized beyond a chance of rehabilitation. In the main, this is due to improper evaluation of the chemico-regulating mechanism in the body economy. The nomenclature, as well, tends to defeat a more clear understanding. It is not unusual to hear physicians make a sharp distinction between metabolic and endocrine disorders when, as a matter of common knowledge, the endocrine system plays a significant rôle in body metabolism. Every endocrine disorder is, therefore, a metabolic disorder, although the reverse is not necessarily true. A classic endocrinopathy, upon which the popular conception of the

subject is erroneously based, is the end-result of a long-standing metabolic imbalance.

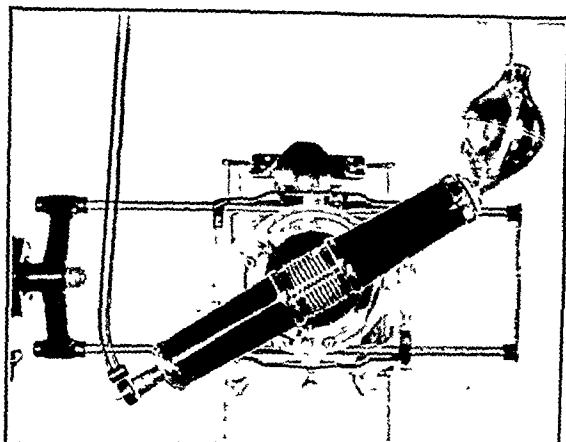
Metabolic disorder, as all chronic disorders, must have a beginning: like many another, the origin is frequently in childhood. Because of the fact that in many instances we are dealing with the mechanism essential to normal growth and development, one should, in disruption of this mechanism, expect to find some alteration of the soma. One does, but the discovery is often late. The reflection of a mild degree of metabolic imbalance on the soma is as insidious as development itself. To wait until all the classic features are reflected in the physical and mental make-up, before suspecting such a disorder, is to lose irreparably the most plastic period of the child's existence.

It is evident that, in order to preclude such an error, one should attempt to make a diagnosis as early as possible. Unfortunately, this is not easy. Laboratory methods, including the biochemical tests available, are unreliable, except in those conditions affecting carbohydrate metabolism. Basal metabolic rate determinations are discouraging in children below the age of eight. Anthropometric measurements, unless carefully interpreted, mean little. If we must, in final analysis, depend upon some alteration of the soma, the roentgenogram probably affords us the earliest and most conclusive evidence of the change. Roentgenologists may observe the bone changes in hyperpara-

¹Presented before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30 Dec 4, 1931

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moval of the hypophysis results in thyroid atrophy. If these things are true of the lower animals, they may equally be true of man. One unquestionably sees children suffering from mild degrees of congenital or

This is 92 per cent over the optimal increment for a normal at this age; and almost four times her previous rate of growth. You will notice by comparison with the normal that her carpal development at the be-

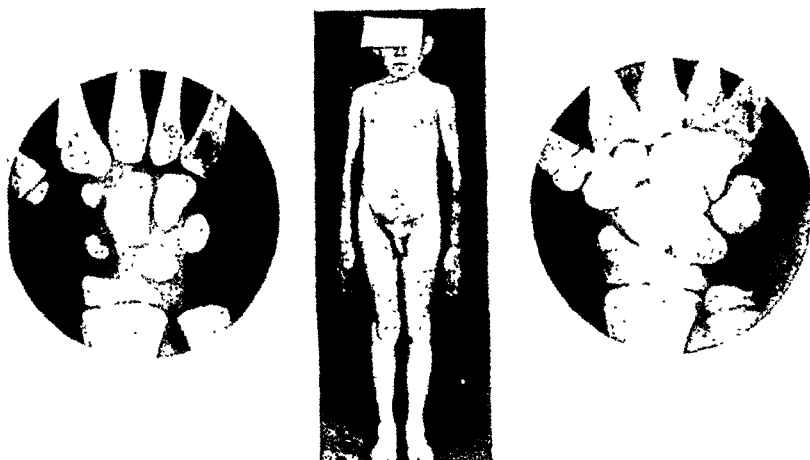


Fig. 2. A hypothyroid boy (age 10 years, 6 months), showing also the carpal development compared to normal. *Left*, patient's wrist; *right*, normal for age.

acquired hypothyroidism who are of average or nearly average height. In Switzerland, cretins are discovered of every size and description. On the other hand, one sees many pituitary dwarfs who present few hypothyroid stigmata. Granting that, in a terminal stage, all of these patients become bi-glandular because of this peculiar sympathy, how may one differentiate between the two early enough to insure a proper therapeutic régime? It is my belief that this may be accomplished in a fairly satisfactory manner through the roentgenogram.

I shall first present a child suffering from what we consider a deficiency of the anterior lobe of the hypophysis. She is at present 10 years and 6 months of age, and has been under observation for 9 months. The treatment has consisted solely of the introduction of a pituitary growth hormone perfected by Dr. Herbert Evans and his colleagues. During this period, we have been able to stimulate her growth 3.2 inches.

ginning of the observation, while small, was fairly complete (Fig. 1).

The next is a boy now 11 years 3 months of age. He is one of four children of a myxedematous mother, three of whom, I feel, are suffering from hypothyroidism. Compare his carpal development (Fig. 2) at the beginning of the observation with the normal and you will see that the carpal differentiation was five years retarded. Next, compare the stature of these children with their respective carpal development (Fig. 3). It is evident that the hypothyroid boy, while much larger in every respect, has not the carpal differentiation equal to the hypopituitary girl. Both are undoubtedly bi-glandular, but the paramount deficiency is brought out with considerable clearness in the roentgenogram. A comparison of the carpal development of the hypothyroid boy before and after 9 months' treatment with thyroid is next submitted (Fig. 4). The rapid unfolding is evident. It appears that

thyroidism long before the patient is incapacitated; and yet, through improper clinical correlation, the diagnosis is rarely made until the patient is badly demineralized. I believe that chronic hypervitaminosis may

resumption of growth, as the case may be. Putnam, Benedict, and Teel (6) have gone so far as to produce a condition simulating acromegaly. In their experimental animals osteophytic overgrowth is

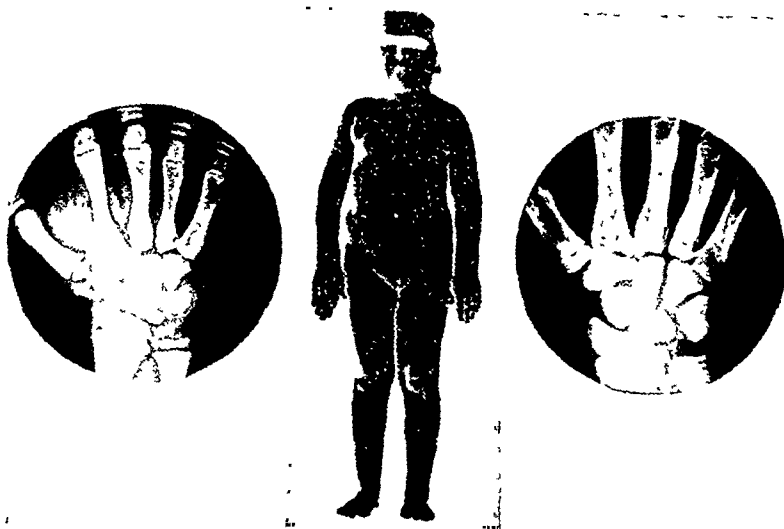


Fig. 1 A pituitary dwarf (age 9 years, 6 months), showing also the carpal development compared to normal *Left*, patient's wrist; *right*, normal for age

ultimately be found to be as evident. Rickets is better understood and rarely allowed to disfigure. There are other metabolic disorders of major importance which have been shown to affect the bony framework. Of these, two have recently been lifted somewhat from the realm of speculation.

From the time of Aschner (1) down to Reichert's (2) classic work, it has been demonstrated that the anterior lobe of the hypophysis is essential to normal growth and development. Ablation of the hypophysis results in dwarfism, a small bony framework, poor deposition of calcium salts, and late closure of the epiphyses. On the other hand, Evans (3, 4), Smith (5), Reichert (2), and others have produced the opposite effect. Artificial introduction of anterior lobe extracts into normal or even hypophysectomized animals results in overgrowth or

demonstrated, a density of framework with deposition of calcium salts throughout the body, and ultimate bridging and ankylosis of the spine. If these animals are injected before the epiphyses are closed, an early closure may be expected.

There is apparently some difference in the action of the thyroid hormone upon the bony framework from that of the hypophysis. B. M. Allen (7) has shown that the removal of the thyroid anlage in the tadpole interferes decidedly with its subsequent differentiation or transmutation, but until late in the condition not so much with its growth. Other observers point out that young thyroidectomized animals soon become cretinoid through improper tissue differentiation but do not immediately cease to grow. These same observers contend, however, that thyroidectomy ultimately results in atrophy of the hypophysis and that re-

the other hand, if the gonad function is destroyed before or during adolescence, either through castration or through primary disease of the gonads, the epiphyses remain open until much later and the long bones

ysis. It would appear that in spite of a retarded differentiation of tissue in hypothyroidism, the epiphyses would close early. This is what I usually find, although I rarely consider a roentgenogram of diagnostic

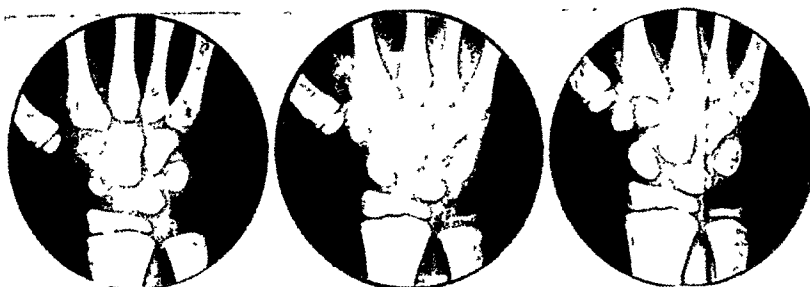


Fig. 4. Roentgenograms of wrist of hypothyroid boy, before and after nine months of treatment. *Left*, before treatment; *middle*, after 6 months; *right*, after 9 months.

continue to grow. The result is eunuchism, or an individual of eunuchoid type. One should bear in mind, however, that the hypophysis is the activator of this entire process, even in the presence of apparently normal gonads. If the entire anterior lobe of the hypophysis is not functioning properly, the gonads will not function and the epiphyses may remain open for an indefinite period. There is a distinct difference between the two, however, both anthropometrically and roentgenologically. While the one is eunuchoid, with long slender bones and open epiphyses (castration—primary hypogonadism), the other remains small, with undeveloped bones and open epiphyses (underfunction of the anterior pituitary—dwarfism—secondary hypogonadism). There are many ramifications of this process which intrigue and baffle the investigator.

The thyroid hormone, on the other hand, appears to have an antagonistic effect upon the genital function, as evidenced by the early onset of catamenia in hypothyroidism—the excessive flooding of hypothyroid women, the cessation of menstruation and loss of libido in hyperthyroidism, etc. This is hard to explain in view of the supposed sympathy between the thyroid and hypophi-

value in any form of thyroidism after the age of twelve. By this time a basal metabolic rate is usually more informative.

In order to afford a better method of comparison between the normal and the abnormal in osseous development, I have recently devised a set of tables and charts of what I consider approximately the optimal. I have been criticized for allowing a liberal variation from these standards as being within the limits of normal, but I am still unconvinced that even a year is adequate in the younger ages. An unfinished study of 560 school children in whom we are attempting to correlate the bone age with the mental age and sex convinces us further that the subject is too new and entirely too complicated for dogma. The tables are subject to the same criticism as all other so-called normal standards and should be used with as much judgment and discretion.

It should be remembered that the cases featured in this discussion are more or less outstanding or classic. They have been selected in order to most clearly present my interpretation of the subject: there lies a wealth of material in between. Many metabolic disorders of importance have not even been mentioned, others only touched upon.

he has made a gain of several years in this short period.' A comparison of the carpal development of the hypopituitary girl at the beginning of anterior pituitary substitution with that 9 months later shows only growth

I have not been able to secure a roentgenogram of the carpal development in one who has suffered from this condition any length of time. It is my belief, however, that such a roentgenogram would show a rapid un-

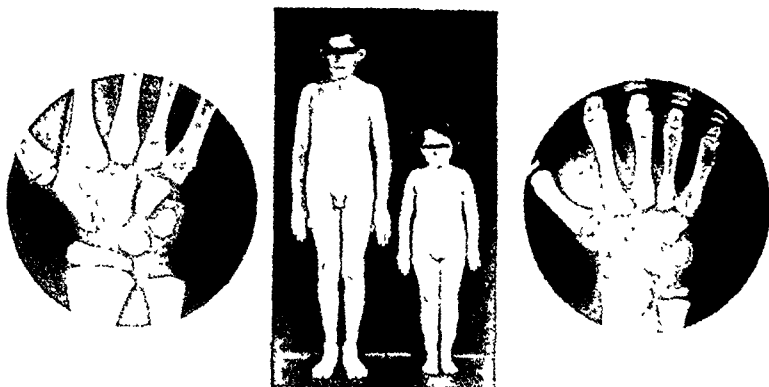


Fig. 3. Comparison of the stature and carpal development of a hypopituitary girl with a hypothyroid boy, both 10 years, 6 months old. *Left*, boy's wrist; *right*, girl's wrist. The osseous age of the boy is 5 years, 6 months; of the girl, approximately normal.

and better massing, since her differentiation was already nearly complete at the beginning of the experiment.

Macrogenitosomia has been attributed to dysfunction of almost every endocrine gland, and yet the one which could produce the entire symptomatology is rarely mentioned. A genital hormone, as well as a growth hormone, has been demonstrated in the anterior lobe of the hypophysis. In macrogenitosomia, or *pubertas præcox*, one sees a child who, at a certain stage of development, is not only very much larger than he should be, but has the genital development of an adult. The carpal development is also found to be advanced: indeed, so much so that the epiphyses close early and stop the growth in childhood. In comparing the wrist of a child of six, suffering from this condition, with the normal, and with that of a hypothyroid, one sees remarkable differences.

Hyperthyroidism is so rare in young children, and is usually discovered so early, that

folding of carpal development. It is quite possible that *pubertas præcox* cases have a high basal rate to account for a part of the rapid osseous unfolding. I can find no record of a case in which the laboratory procedure has been attempted in a closed chamber, although it probably has been done.

In carrying this study a step further, one comes to the period of adolescence and the epiphyseal closure time. It is well established that, after a certain age, the epiphyses start closing and a brake is put upon the long bone growth, an observation so thoroughly illuminated by Todd (9). Apparently no one understands this phenomenon, but it appears to be closely associated with gonad function. In cases of *pubertas præcox*, in which the gonads develop and function sometimes as early as the fourth year of life, the epiphyses immediately start closing. The earlier the onset of catamenia or the concomitant sexual ripening in the male, the earlier the epiphyseal closure. On

effects of such radiation was published in 1924 by Gosset, Gutmann, Lakhovsky, and Magrou (3), who reported the effects of very high frequency electro-magnetic radiation emitted by a vacuum tube oscillator upon plant tumors caused in the geranium by *Bacterium tumefaciens*. They reported that three geranium plants bearing tumors caused by inoculation with this organism were exposed to the radiations emitted by a vacuum tube oscillator at a frequency said to be about 150,000,000 cycles per second. One plant was given two exposures of three hours on consecutive days, one plant three, and one plant eleven such exposures. After 16 days from the first exposure the tumors, after growing in the interval, began suddenly to necrose. The necrotic process was said to be complete in about fifteen days so that the tumors could be detached by slight traction. In 16 control plants the tumors grew rapidly to great size and recurred after excision. The paper, however, contains no details as to the apparatus nor the method of exposure to the radiation.

In the Fall of 1924 the writer began his experiments on the action upon small laboratory animals of electro-static fields excited by very high frequency electro-magnetic radiation. As a preliminary to these studies, considerable work had to be done in testing the suitability of various types of oscillators for the work. Finally the type of oscillator described by Huxford (6) for frequencies higher than 60,000,000 cycles per second, and the well known Hartley circuit for frequencies lower than this were found to be satisfactory.

In these series of experiments, each mouse was placed in a box of insulating material of such size as to hold comfortably a 20-22 gram mouse, while permitting a minimum of twisting or turning. This box was inserted between the plates of a condenser which formed part of a circuit tuned to the frequency at which the oscillator was working.

When this circuit was inductively coupled to the oscillator, a current of the same frequency flowed in the circuit, the strength of which could be varied by increasing or diminishing the coupling. The strength of the current was measured by a calibrated platino-tellurium thermocouple, symmetrically inserted in the circuit.

It will be noted that when a mouse is enclosed in a box of non-conducting material exposed in this way to the action of the high frequency currents in the circuit, no free electrons from the external parts of the circuit can enter, nor can they flow out from the body of the experimental animal. The mice, however, were subjected to the action of a displacement current in which the electrons of the body cells, according to their state of freedom, would pass from molecule to molecule, or, if bound, be stressed in a direction the polarity of which alternates at the oscillator frequency. These conditions, therefore, differ considerably from those in the therapeutic applications of diathermy, for here the body part being treated is conductively connected in the high frequency circuit, so that the current flows through the intervening tissues.

When mice were exposed to high frequency currents in the manner just described, severe symptoms made their appearance, followed by death, if the exposure were prolonged more than a few minutes. Mice dying in this way felt warm to the touch, and rectal temperatures immediately after death ranged from 42.2° to 43.1° C. and occasionally to 44° C. The death of the mice, therefore, was due primarily to the heating effects of the high frequency electro-static field.

With sub-lethal exposures, in many instances, small hemorrhagic areas can be observed along the course of blood vessels of the ears which, in the course of 48 hours, become necrotic and drop off. The tail, too, frequently shows numerous ecchymotic

It is obvious that so large a subject could never be elucidated in a short paper.

In closing, I wish to say that while the effect of metabolic disorders upon osseous development is little understood, it is apparent. The subject is deserving of more serious thought and consideration. Only an open mind and a closer co-operation between the clinician, the biochemist, and the roentgenologist will ultimately decide the true value of osseous development as an index of metabolism.

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BIOLOGICAL EFFECTS OF VERY HIGH FREQUENCY ELECTROMAGNETIC RADIATION¹

By J. W. SCHERESCHEWSKY, M.D., BOSTON

THE biologic effects of radiation in general are properly regarded as an investigative field of major importance. In the past, certain regions in the whole spectrum of radiation have been inaccessible to investigation because generators of frequencies corresponding to these regions have been lacking.

The advent of short wave radio-communication, brought about by the development, in the last decade, of the vacuum tube oscillator and the associated circuits, has permitted the generation of electro-magnetic radiation of frequencies which may be varied at will from less than 100 to about 400,000,000 cycles per second. Moreover, the radiations generated in this way consist

of continuous waves of relatively pure form, sharply emitted at the frequency to which the circuit is tuned.

In this respect the oscillations differ from those generated in the usual high frequency apparatus used for therapeutic purposes. Here the oscillations are produced by condenser discharge across a spark gap. Such oscillations have a large decrement; the wave form is impure, giving rise to many harmonics; the emitted wave is broad, and consistent operation at frequencies much above one or two million cycles per second is difficult to obtain. It is only natural that, with the development of means for the generation of very high frequency electro-magnetic radiation, the biologic effects of these oscillations should be investigated. Apparently the first paper on the biologic

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov 30-Dec. 4, 1931.

effects of such radiation was published in 1924 by Gosset, Gutmann, Lakhovsky, and Magrou (3), who reported the effects of very high frequency electro-magnetic radiation emitted by a vacuum tube oscillator upon plant tumors caused in the geranium by *Bacterium tumefaciens*. They reported that three geranium plants bearing tumors caused by inoculation with this organism were exposed to the radiations emitted by a vacuum tube oscillator at a frequency said to be about 150,000,000 cycles per second. One plant was given two exposures of three hours on consecutive days, one plant three, and one plant eleven such exposures. After 16 days from the first exposure the tumors, after growing in the interval, began suddenly to necrose. The necrotic process was said to be complete in about fifteen days so that the tumors could be detached by slight traction. In 16 control plants the tumors grew rapidly to great size and recurred after excision. The paper, however, contains no details as to the apparatus nor the method of exposure to the radiation.

In the Fall of 1924 the writer began his experiments on the action upon small laboratory animals of electro-static fields excited by very high frequency electro-magnetic radiation. As a preliminary to these studies, considerable work had to be done in testing the suitability of various types of oscillators for the work. Finally the type of oscillator described by Huxford (6) for frequencies higher than 60,000,000 cycles per second, and the well known Hartley circuit for frequencies lower than this were found to be satisfactory.

In these series of experiments, each mouse was placed in a box of insulating material of such size as to hold comfortably a 20–22 gram mouse, while permitting a minimum of twisting or turning. This box was inserted between the plates of a condenser which formed part of a circuit tuned to the frequency at which the oscillator was working.

When this circuit was inductively coupled to the oscillator, a current of the same frequency flowed in the circuit, the strength of which could be varied by increasing or diminishing the coupling. The strength of the current was measured by a calibrated platino-tellurium thermocouple, symmetrically inserted in the circuit.

It will be noted that when a mouse is enclosed in a box of non-conducting material exposed in this way to the action of the high frequency currents in the circuit, no free electrons from the external parts of the circuit can enter, nor can they flow out from the body of the experimental animal. The mice, however, were subjected to the action of a displacement current in which the electrons of the body cells, according to their state of freedom, would pass from molecule to molecule, or, if bound, be stressed in a direction the polarity of which alternates at the oscillator frequency. These conditions, therefore, differ considerably from those in the therapeutic applications of diathermy, for here the body part being treated is conductively connected in the high frequency circuit, so that the current flows through the intervening tissues.

When mice were exposed to high frequency currents in the manner just described, severe symptoms made their appearance, followed by death, if the exposure were prolonged more than a few minutes. Mice dying in this way felt warm to the touch, and rectal temperatures immediately after death ranged from 42.2° to 43.1° C. and occasionally to 44° C. The death of the mice, therefore, was due primarily to the heating effects of the high frequency electro-static field.

With sub-lethal exposures, in many instances, small hemorrhagic areas can be observed along the course of blood vessels of the ears which, in the course of 48 hours, become necrotic and drop off. The tail, too, frequently shows numerous ecchymotic

areas: it may subsequently become affected with dry gangrene and drop off. In other instances areas of alopecia develop, particularly in the supra-orbital region and at the tip of the snout.

In the course of preliminary observations, it soon became evident that the effects of exposure to different frequencies were not quite the same, a current of constant value proving more lethal at a given range of frequencies than at others. A series of experiments were, therefore, undertaken in which mice, under standard conditions of temperature and relative humidity, were exposed to the same current flowing in the auxiliary circuit (338 milliamperes), but in which the frequencies were varied in steps of about 10 per cent from a maximum of 135,000,000 to a minimum of 8,300,000 cycles per second.

As a result of these experiments, it was found that the lethal effect was most marked in a band of frequencies extending from about 66,000,000 to 18,000,000 cycles per second, the effect diminishing in one direction in the band extending from 18,000,000 to 9,000,000 cycles per second, and in the other from 66,000,000 to 135,000 cycles per second.

In view of the fact that, in the foregoing experiments, the lethal effect of some frequencies seemed more pronounced than that of others, the thought occurred that, under suitable conditions, oscillations at certain frequencies might prove more injurious to some tissue cells than to others; in other words, that there might be some differential action upon tissue with respect to frequency.

Evidently the tissue cells of transplantable tumors should form admirable experimental material for this purpose. Because of the high percentage of takes (averaging 95 per cent), the rapid rate of growth, and the relative rarity of recession (2 per cent), Mouse Sarcoma CR 180 was selected as the transplantable tumor for this purpose.

The preliminary experiments were carried out at practically uniform frequencies of from 66,000,000 to 68,000,000 cycles per second because the previous set of experiments showed that oscillations of this frequency were lethal to mice, and because of a highly speculative hypothesis (undoubtedly incorrect) that the mechanical rate of vibration of which a minute spheroid of the size of a tumor cell is capable might render it particularly sensitive to electrical vibrations of the same order of frequency.

The tumors were subjected to the action of high frequency currents in a tuned auxiliary circuit coupled to the oscillator, by means of copper electrodes (covered with an insulating varnish), which were applied, one on each side of the tumor and maintained in contact therewith. The currents registered by a thermo-milliammeter, placed symmetrically in the circuit, varied from 250 to 350 milliamperes and the duration of an exposure from 2 to 3 minutes.

A large number of mice (about 400) were treated in this way, with the result that about 100 mice, or 25 per cent, recovered from their tumors, and remained tumor-free. When properly carried out, the treatment seemed to cause the mice no pain, and, while immediately after the treatment the tumor felt softer and smaller to the touch, at least the rise in the local temperature was trifling. In some instances a single treatment caused shrivelling and drying up of the tumor; in others, several treatments were required.

In collaboration with Dr. H. B. Anderson (20), of the Department of Preventive Medicine and Hygiene of the Harvard Medical School, the effects of the same method of treatment upon the Rous fowl sarcoma planted in the skin, comb, and wattles of chickens were studied. In seven chickens which were inoculated a total of 15 times, it was possible to bring about by the treatment just described a complete re-

cession of the tumor, while in an equal number of chickens, one inoculated in the comb, one in the wattle, and five in the skin of the breast, only retardation of the tumor growth was produced, the fowls ultimately dying from extensive tumor growth.

Later on it was found in the case of mice inoculated with Mouse Sarcoma 180, rats inoculated with Rat Sarcoma No. 10, and also chickens inoculated with the Rous fowl sarcoma, that frequencies between 90,000,000 and 100,000,000 cycles per second were considerably more effective in treating these tumors than the range of frequencies 66,000,000 to 68,000,000 cycles at which the preliminary experiments were carried out. With the higher frequencies, from 60 to 75 per cent of recoveries were obtained in tumors ranging from 15 to 20 millimeters in length for mice and from 30 to 50 millimeters in length in rats.

Mention has already been made of the fact that, after treatment, the temperature of the tumors did not appear sensibly raised to the touch. However, tactile impressions are often notoriously false, so observations were made as to the temperature rise taking place in the interior of the tumor during treatment. This was carried out by inserting a thermocouple made of an insulated constantan wire in the interior of a 22-gauge hypodermic needle into the interior of the tumor along its long axis. By this means it was found that although the skin was but little heated by the high frequency field, the temperature in the interior of the tumor rapidly rose, reaching from 48° to 49.6° C. in from one and a half to two minutes, according to the size of the tumor. Other experiments made by immersing tumor fragments in Locke's solution heated to various temperatures for various times showed that heating fragments of mouse sarcoma to temperatures between 48° and 49° C. for 3 minutes prevented their growth when transplanted into mice.

It is evident, therefore, that the curative effects noted were due to the heating of the tumor cells in the high frequency field. Incidentally it may be remarked that it was also found possible to bring about the recession of tumors by placing on each side a hollow copper applicator through which hot water was circulated until the temperature of the interior of the tumors, as shown by an inserted thermocouple, had reached from 48° to 49° C. However, it took a considerably longer time to raise the internal temperature of the tumor the required amount by this method than by the action of the high frequency currents.

In 1929, Christie and Loomis (2) repeated the writer's experiments on the heating effects of a high frequency field on mice, investigating in similar fashion the effect of frequencies varying from 150,000,000 to 7,000,000 cycles per second. Their results were definitely at variance with those obtained by the writer in that, with fields up to a frequency of 50,000,000 cycles, they found the lethality of the field to be proportionate to its intensity, one frequency being just as lethal as another; above 50,000,000 cycles, however, the lethality of the radiation appeared to diminish. They believed that one source of error in the writer's experiments was the carrying out of the observations at constant current, determined by a thermocouple symmetrically located in the circuit. Instead, they adjusted the circuit in which the mice were exposed at different frequencies, so that a M/20 salt solution thermometer held in the condenser field showed a temperature rise in degrees centigrade per minute of the same order at each frequency investigated.

However, as pointed out by McLennan and Burton (13), this, too, leads to erroneous conclusions, since, as will be more fully discussed, the rate of heating of a solution of electrolyte of a given concentration changes with the frequency.

areas: it may subsequently become affected with dry gangrene and drop off. In other instances areas of alopecia develop, particularly in the supra-orbital region and at the tip of the snout.

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been able, by proceeding cautiously, to produce and maintain for several hours artificial fevers of from 104° to 105° F. In their experiments they found a frequency of about 10,000,000 cycles the best adapted to their purpose, the subject being placed between condenser plates 28×18 inches covered with hard rubber to prevent contact burns, the subject, with the exception of the head, inclosed in a box of non-heat-conducting material. Carpenter feels that this method for the production of artificial fevers may in the future be susceptible of wide therapeutic application.

At the present time clinical applications of this method of producing artificial fevers are being investigated at several medical centers, notably at the University of Rochester, where, under the direction of Carpenter, Murlin, and Warren, both laboratory and clinical studies of the therapeutic possibilities of the method are under way. At a symposium held at the University of Rochester in May, 1931, clinical demonstrations were made of the favorable effects of such fevers upon paresis, gonorrheal arthritis, syphilis, and rheumatic arthritis. The results were such as distinctly to encourage the investigators to continue their inquiry.

With respect to the possible therapeutic applications of the high frequency electrostatic field, we should keep the following in mind: In the first place, the heating is produced in a somewhat different manner than in ordinary diathermy. In conventional diathermy there is a current flow between the electrodes and, though it cannot be denied that the capacity of the tissues and their di-electric constants play some part in the heating process, still, at the relatively low frequencies employed, and at the concentrations of electrolytes prevailing in the tissues and body fluids, these effects are small, compared to the heat generated by the resistance of the tissues to the current flow.

Schliephake (21-23), in 1928 and 1929, has compared the relative heating of vari-

ous kinds of tissue both in the condenser field and with conventional diathermy. He finds that, in the condenser field, the heating is more nearly uniform than in diathermy, in which there is excessive heating of the subcutaneous tissues, as compared to the heating in the intervening portions of the body. For this reason it would seem practicable, from the action of the high frequency condenser field, to raise the temperature of deep-seated organs to a considerable degree without, at the same time, over-heating the subcutaneous tissues.

So far we have concerned ourselves only with the heating effects of the high frequency condenser field. Christie and Loomis (2) and Kahler, Chalkley, and Voegtlin (7), who, in 1929, studied the effects of the high frequency condenser field upon the unicellular organism *Paramecium*, came to the conclusion that no other than a heating effect was demonstrable.

However, in 1930, Mellon, Szymanowski, and Hicks (14), following up the work of D'Arsonval, who found, about thirty-five years ago, that high frequency currents of about 200,000 cycles per second diminished the strength of diphtheria toxin, carried out a series of experiments, using a frequency of 158,000,000 cycles per second, in which diphtheria toxin was exposed in a film about 0.5 mm. in thickness between the walls of concentric tubes, while a chilled fluid was circulated in the inner tube. The type of fluid chosen for cooling was important because absorption of the electro-magnetic waves by the central core of cooling fluid might condition a loss of energy available to affect the toxin. Benzol was chosen because its balanced molecular structure gives rise to no resultant dipole, and since its dielectric constant is the same at all frequencies, no absorption bands were to be anticipated. It was found that the radiation was effective in reducing the activity of the toxin even at temperatures as low as 15° C.

McKinley (12), in 1930, also reported

In 1928, Dr. W. R. Whitney, Director of the General Electric Company's Research Laboratory, observed in connection with test runs of a 20-kilowatt short wave oscillator that the mouth temperature of one bystander rose 2.2° F. in 15 minutes, while several other individuals exhibited a somewhat smaller rise in temperature. It was also noted that solutions of electrolytes of different concentrations, when placed in the electro-static field of the oscillator, did not heat alike, one concentration heating faster than another at one frequency, while this relation might be reversed if the frequency were sufficiently changed.

These observations have led to two lines of investigation: (1) the study of the heating of electrolytes in high frequency fields, and (2) investigation of the use of the high frequency electro-static field as a means of producing artificial fevers for therapeutic purposes in human beings.

The heating of electrolytes in high frequency electro-static fields was first investigated by Hosmer (5) and then, among others, by Richards and Loomis (17), McLennan and Burton (13), and more recently by Pätzold (16).

Without taking the time to describe the methods employed, nor to discuss the mathematical analysis of the results, the main facts shown by these inquiries are, according to McLennan and Burton (13), as follows: The heating of a solution of electrolyte in a high frequency electro-static field depends, not upon the composition, but on the specific conductivity of the liquid, and rises to a maximum for a certain conductivity whatever the size and shape of the specimen heated. The conductivity at which the maximum effect occurs is proportional to the frequency, *i.e.*, at lower frequencies the maximum heating is observed in solutions of lower concentration than at higher frequencies. For example, at 1,560,000 cycles per second the concentration of potassium chlorid showing a maximum heating effect

is 0.00038 gram-molecules per liter. At 5,560,000 cycles it is 0.002, or five times greater; at 22,000,000 cycles, the concentration is about 0.005, and at 26,100,000 cycles it is about 0.01. In the neighborhood of 300,000,000 cycles, according to previous observations, this concentration is about 0.01.

For the low conductivities involved, the so-called "skin effect" is shown both by experiment and theory to be negligible and heating effects are produced throughout the depth of the specimen to be heated. As much as the intensity of the field within the specimen is influenced by its orientation with respect to the external field, this too is important, the heating effect observed depending both upon the dielectric constant and the shape and orientation of the external field. In a heterogeneous body, such as the laboratory animal, the distribution of the field in the interior of the body will be determined largely by the respective dielectric constants of its component tissues; the degree of heating at that particular frequency will be determined by their respective conductivities.

McLennan and Burton (13) point out that if we knew the electric properties of the component parts of the body, we would be able to make the proper choice of frequency, be able to favor the heating of one portion over another, although the effect of such selective heating would tend to be minimized by exchange between neighboring parts. Nevertheless we have here a therapeutic possibility which, if susceptible of development, would have a wide application.

Artificial Fevers.—The rapid heating of the animal body in the high frequency electro-static field has been utilized by Carpenter and Page (1) in the production, for therapeutic purposes, of artificial fever in dogs. Basing their work on Whitney's observations of the elevation of body temperature of persons working in the field of a powerful short wave transmitter and using a rat designed by the Research Laboratory of the General Electric Company, they

been able, by proceeding cautiously, to produce and maintain for several hours artificial fevers of from 104° to 105° F. In their experiments they found a frequency of about 10,000,000 cycles the best adapted to their purpose, the subject being placed between condenser plates 28×18 inches covered with hard rubber to prevent contact burns, the subject, with the exception of the head, inclosed in a box of non-heat-conducting material. Carpenter feels that this method for the production of artificial fevers may in the future be susceptible of wide therapeutic application.

At the present time clinical applications of this method of producing artificial fevers are being investigated at several medical centers, notably at the University of Rochester, where, under the direction of Carpenter, Murlin, and Warren, both laboratory and clinical studies of the therapeutic possibilities of the method are under way. At a symposium held at the University of Rochester in May, 1931, clinical demonstrations were made of the favorable effects of such fevers upon paresis, gonorrheal arthritis, syphilis, and rheumatic arthritis. The results were such as distinctly to encourage the investigators to continue their inquiry.

With respect to the possible therapeutic applications of the high frequency electrostatic field, we should keep the following in mind: In the first place, the heating is produced in a somewhat different manner than in ordinary diathermy. In conventional diathermy there is a current flow between the electrodes and, though it cannot be denied that the capacity of the tissues and their di-electric constants play some part in the heating process, still, at the relatively low frequencies employed, and at the concentrations of electrolytes prevailing in the tissues and body fluids, these effects are small, compared to the heat generated by the resistance of the tissues to the current flow.

Schliephake (21-23), in 1928 and 1929, has compared the relative heating of vari-

ous kinds of tissue both in the condenser field and with conventional diathermy. He finds that, in the condenser field, the heating is more nearly uniform than in diathermy, in which there is excessive heating of the subcutaneous tissues, as compared to the heating in the intervening portions of the body. For this reason it would seem practicable, from the action of the high frequency condenser field, to raise the temperature of deep-seated organs to a considerable degree without, at the same time, over-heating the subcutaneous tissues.

So far we have concerned ourselves only with the heating effects of the high frequency condenser field. Christie and Loomis (2) and Kahler, Chalkley, and Voegtlin (7), who, in 1929, studied the effects of the high frequency condenser field upon the unicellular organism *Paramcium*, came to the conclusion that no other than a heating effect was demonstrable.

However, in 1930, Mellon, Szymanowski, and Hicks (14), following up the work of D'Arsonval, who found, about thirty-five years ago, that high frequency currents of about 200,000 cycles per second diminished the strength of diphtheria toxin, carried out a series of experiments, using a frequency of 158,000,000 cycles per second, in which diphtheria toxin was exposed in a film about 0.5 mm. in thickness between the walls of concentric tubes, while a chilled fluid was circulated in the inner tube. The type of fluid chosen for cooling was important because absorption of the electro-magnetic waves by the central core of cooling fluid might condition a loss of energy available to affect the toxin. Benzol was chosen because its balanced molecular structure gives rise to no resultant dipol, and since its dielectric constant is the same at all frequencies, no absorption bands were to be anticipated. It was found that the radiation was effective in reducing the activity of the toxin even at temperatures as low as 15° C.

McKinley (12), in 1930, also reported

In 1928, Dr. W. R. Whitney, Director of the General Electric Company's Research Laboratory, observed in connection with test runs of a 20-kilowatt short wave oscillator that the mouth temperature of one bystander rose 2.2° F. in 15 minutes, while several other individuals exhibited a somewhat smaller rise in temperature. It was also noted that solutions of electrolytes of different concentrations, when placed in the electro-static field of the oscillator, did not heat alike, one concentration heating faster than another at one frequency, while this relation might be reversed if the frequency were sufficiently changed.

These observations have led to two lines of investigation: (1) the study of the heating of electrolytes in high frequency fields, and (2) investigation of the use of the high frequency electro-static field as a means of producing artificial fevers for therapeutic purposes in human beings.

The heating of electrolytes in high frequency electro-static fields was first investigated by Hosmer (5) and then, among others, by Richards and Loomis (17), McLennan and Burton (13), and more recently by Pätzold (16).

Without taking the time to describe the methods employed, nor to discuss the mathematical analysis of the results, the main facts shown by these inquiries are, according to McLennan and Burton (13), as follows: The heating of a solution of electrolyte in a high frequency electro-static field depends, not upon the composition, but on the specific conductivity of the liquid, and rises to a maximum for a certain conductivity whatever the size and shape of the specimen heated. The conductivity at which the maximum effect occurs is proportional to the frequency, *i.e.*, at lower frequencies the maximum heating is observed in solutions of lower concentration than at higher frequencies. For example, at 1,560,000 cycles per second the concentration of potassium chlorid showing a maximum heating effect

is 0.00038 gram-molecules per li 5,560,000 cycles it is 0.002, or five times greater; at 22,000,000 cycles, the concentration is about 0.005, and at 26,100,000 cycles it is about 0.01. In the neighborhood of 300,000,000 cycles, according to previous observations, this concentration is about 0.01.

For the low conductivities involved, the so-called "skin effect" is shown both by experiment and theory to be negligible. The heating effects are produced throughout the depth of the specimen to be heated. As much as the intensity of the field within the specimen is influenced by its orientation with respect to the external field, this too is important, the heating effect observed depending both upon the dielectric constant and shape and orientation of the external field. In a heterogeneous body, such as the laboratory animal, the distribution of the field in the interior of the body will be determined largely by the respective dielectric constants of its component tissues; the degree of heating at that particular frequency will depend by their respective conductivities.

McLennan and Burton (13) point out that if we knew the electric properties of the component parts of the body, we would be able to make the proper choice of frequency, but as we do not, we favor the heating of one portion over another, although the effect of such selective heating would tend to be minimized by exchange between neighboring parts. Nevertheless we have here a therapeutic possibility which, if susceptible of development, would have a wide application.

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ANY part of the pleura-covered lung which protrudes beyond the normal boundaries of the thoracic cage and invades the subcutaneous tissues can rightfully be designated as a true hernia. True lung hernia should not be confused with evisceration or prolapse, an error not infrequently made by early writers. Lung hernia is a very rare condition; up to the present time, less than 200 cases have been reported in the literature. Because of its rarity, clinicians of wide experience have had little opportunity to observe it. Much information in the literature is inaccurate and confusing and, therefore, some early reports are not dependable. Several names have been applied to lung hernia, as pneumonocoele, pneumocoele, and pulmonary hernia.

Considering the great number of stab and bullet wounds in warfare and civilian life, and crushing injuries of the chest, it is surprising that lung hernia is not more frequent. In an extensive war experience with chest wounds, Makins observed one case, while Adams reported five out of 20,000 chest wounds in the Russian-Japanese War (1). It is also noteworthy that, with frequent fractures of the ribs, pneumothorax rarely occurs. In a study of 89 cases of fractured ribs requiring hospitalization, 16 were treated for other complications but only one instance occurred in which pneumothorax resulted (2).

HISTORY

As early as 1891, Rolandus published a report of the first case operated upon for

certain results as indicating a possible specific action. Exposure of the whole of the vertebral column of the frog at 90,000,000 cycles per second resulted in all cases in an immediate response, the effect being a violent muscular contraction of the hind legs. The experiments were repeated with external heat as the agent, and the characteristic reaction of the leg muscles, as observed in the high frequency condenser field, failed to take place.

The writer has found that, when a Straub preparation of a frog's heart is placed in a high frequency condenser field at 90,000,000 cycles per second, the heart, after undergoing a period of acceleration in its beat, stops in diastole, frequently showing a 2:1 heart block before the arrest. Upon cutting off the current the beat is resumed, returning to normal after a brief preliminary irregularity. It is possible to obtain this effect on the heart if the Ringer's solution used to perfuse the heart and to drip on its exterior (to avoid drying) is chilled to 4° C. Control hearts were either perfused with gradually heated Ringer's solution or suspended in a gradually heated air chamber. In the first instance, after preliminary acceleration, irregularities in the beat began to be manifest at a temperature of 41° C., but arrest of the heart's action took place only when the Ringer's solution was preheated to 47° C. In the hot air chamber it required an external temperature of approximately 50° C. to arrest the heart.

These experiments, however, are put forward with reserve, as it required considerably more current in the coupled circuit to stop the heart when the Ringer's solution was chilled than when it entered the heart at laboratory temperature (about 20° C.), so it is possible that the observed effects may have been due to heating of the conducting bundles.

At this point the observation may be made that the heating effects of the

tissue are pronounced. Schlie (23) in his studies found that the heating rate for brain tissue is high. J. Burdette (quoted by McKinley 1929, that of many organic compounds which they measured, which is characteristic of nervous tissue, the highest heating rate.

McKinley (9-11) found, in experiments to the action of the high frequency condenser field, that in holometabolous insects, in which the nervous system is highly organized in the adult forms, the time of lethal exposure was about six times longer in the larval than in the adult. In hemimetabolous insects, in which but little difference exists in the nervous organization of the adult and the nymph, the lethal time was about the same.

Such, then, is the status of our knowledge in regard to the biological effects of ultra-high frequency electromagnetic waves. It appears to be a field worthy of investigation, and in the future, may well provide valuable therapeutic aids.

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Considering the great number of stab and bullet wounds in warfare and civilian life, and crushing injuries of the chest, it is surprising that lung hernia is not more frequent. In an extensive war experience with chest wounds, Makins observed one case, while Adams reported five out of 20,000 chest wounds in the Russian-Japanese War (1). It is also noteworthy that, with frequent fractures of the ribs, pneumothorax rarely occurs. In a study of 89 cases of fractured ribs requiring hospitalization, 16 were treated for other complications but only one instance occurred in which pneumothorax resulted (2).

HISTORY

As early as 1891, Rolandus published a report of the first case operated upon for

lung hernia (3). Chassier mentions herniated lung and was one of the first to accord it special consideration (4). Cloquet, in 1819, reported a case of a young man, age 32 years, crushed under a gun carriage, who made a good recovery (5). Morel-Lavallée, who collected 32 cases, gave us a very comprehensive classification (6). Lake mentions a case of lung hernia caused by the handle of a wheelbarrow penetrating the side of the chest (7). Dufour reports a case of traumatic hernia cured without operation, after much loss of blood (8). In 20,000 wounds in the War of the Rebellion, only seven lung hernias were reported. Cockle published a case of double pulmonary hernia (9). Lewtas (10) and Hirschsprung (11) each reported a case of congenital hernia. Spontaneous pneumocele from violent exertion in weight lifting was reported by Masoti (12). Hagentorn (13) mentions pneumotomy in pneumocele. In 1893, Pitt (14) affirmed that the protrusion of hernia may occur at the time of trauma or any time later. Lopez (15) reported resection of the lung for hernia, with recovery. Tuffier (16) mentions resection of the lung and Knox (17) reported two cases of hernia of the lung into the neck. From 1895 to 1904 several cases of hernia of the lung and its treatment were reported (18, 19, 20, 21, 22). Vulpius (23) reported a case of traumatic hernia of the lung which, five weeks after plastic operation, was discharged, cured. Koennecke (24) reports a case of strangulated, pulmonary hernia occurring in a male of 39 years, of sedentary occupation, in whom the protrusion appeared suddenly from over-exertion. The lungs and thoracic wall were otherwise unaffected. The swelling, which was of six months' duration, was observed to become irreducible on the morning before the patient's admission to the hospital. The man suffered shooting pains in respiration, cough sensation, and pains which radiated into the

arm, becoming most violent in the prone position. A painful, egg-shaped protrusion of pillow-like consistency above the left clavicle was removed and the slit of 2 cm. in the pleural cavity was sutured and covered with a flap of muscle from the sternocleidomastoid. The patient made an uneventful recovery. The author considers this a congenital or a spontaneous lung hernia since he was undetermined whether the pleural gap, the place of predilection for hernia, had been congenital or had originated from previous trauma from over-exertion. In the opinion of the writer, this can be considered a spontaneous hernia, since the weak spot of *locus minoris resistentie* existed as shown by the congenital defect where anatomically a weakened area occurs.

Morel-Lavallée made the following classification:

I.—According to Location

- (A) Diaphragmatic
- (B) Thoracic
- (C) Cervical

II.—According to Etiology

- (A) Congenital
- (B) Acquired
 - 1. Traumatic
 - 2. Consecutive
 - 3. Spontaneous
 - 4. Pathologic.

Most authors abide by this grouping, although some object to the *consecutive type* since it invariably follows cases of traumatism (6).

CONGENITAL LUNG HERNIA

Hochsinger (25) regarded all lung hernias as congenital during the first weeks of life. Congenital pneumocele is due to defective development in any portion of the thoracic wall. These defects, which are covered by fibrous tissue, arise from intra-uterine abnormalities such as amniotic

bands, pressure of fetal limbs against the chest wall, pressure from uterine masses or fibroids, and a lack of amniotic fluid. *In utero*, with the lungs solid and in a state of collapse, no evidence of hernia is noted. The individual may grow to adult life before signs of hernia first appear and, because of this, confusion may arise as to its congenital origin.

The hernia may be cervical, thoracic, or diaphragmatic in location. Beale (26) reports the only recorded case of diaphragmatic hernia, following an injury to the diaphragm through which lung protruded, with intestinal perforation and a subphrenic abscess. The patient succumbed to general peritonitis. Postmortem revealed the lung tissue in the subphrenic abscess but no opening in the diaphragm was found. The cervical group is relatively rare; the thoracic is most common. Montgomery and Lutz (27), in an extensive review of the literature, made a statistical study and reported 165 cases, citing one in detail.

165 Cases Reported

Congenital	18 per cent
Traumatic	50 per cent
Spontaneous	32 per cent
Cervical	16 { Left..... 6 Right.....10
Anterior chest wall	57 { Left.....23 Right.....34
Posterior chest wall	5 { Left..... 2 Right..... 3

ANATOMIC CONSIDERATIONS

In the congenital group, the extension of the pleural sac into the neck favors this site as the most common location. The dome of the pleura limits the excursion of the apex of the lung, strengthened by the deep cervical fascia and the adjacent neck muscles. The weakest region is the area between the scalenus anticus and the sternomastoid muscles; therefore, hernia usually

occurs at this site. Near the sternum and the vertebræ anteriorly and posteriorly are two other weak sites. Anteriorly the costal cartilages lack the group of external intercostal muscles; posteriorly the internal groups extend only to the angle of the ribs. Herniation occurs more commonly anteriorly, since the pectoral group of muscles does not afford the wall of resistance offered by the strong back muscles, namely, the latissimus dorsi, the trapezius, and the rhomboideus.

Most writers are agreed that a hernia of the lung is dependent upon a *locus minoris resistentiæ*, such as occurs in the wall of the thoracic cage, associated with an increased pressure within the lungs themselves. Pressure changes are due to either voluntary or involuntary contractures of the muscles of the chest wall, combined with varying degrees of closure of the glottis. Long continued strain, especially that applied day by day, is responsible for the production of all hernias and this is applicable, in a great measure, to pneumocele (28).

SPONTANEOUS PNEUMOCELE

When any weakened portion of the chest wall gives way under the strain of increased intrathoracic pressure, a spontaneous hernia occurs. The *locus minoris resistentiæ* pre-exists, to which is added an abnormal increase in the intrapulmonary pressure—two factors which must be present to cause a spontaneous hernia. Anatomically, diastasis of muscles, absence of ribs, or any defect in the structure of the thoracic wall have been reported as etiologic factors. Persistent paroxysmal cough—as in bronchitis, bronchial asthma, whooping cough—lung suppuration, or tuberculosis, etc., may be the exciting cause. Common causes, such as blowing of glass and musical instruments, heavy lifting, muscular strain at labor, have all been mentioned. Wightman (20) records the case of a flute player who developed a

spontaneous pneumocele. Again it is recorded in a case of tuberculosis, developing secondarily to the chronic cough (29).

PATHOLOGIC PNEUMOCELE

Some authors are of the opinion that lung hernia may be caused by the following pathologic conditions: rupture of a lung abscess through the pleura and chest wall, abscess of the chest wall and breast, suppuration of lung breaking through the chest wall, the latter sometimes associated with degenerative malignancy, and empyema, with complications invading the chest wall and lung.

TRAUMATIC PNEUMOCELE

Lung hernia following injury presents by far the greatest number of acquired cases; stab wounds and crushing injuries of the chest, with gunshot and shrapnel wounds, form the most common etiologic factors. Lung hernia in scars and following operations on the chest, as the Estlander operation, have been reported. Severe contusions of the chest arising from injuries such as squeezing forces, the being hurled against seats, other persons, or a car may result, not only in fractured ribs, but in serious damage to the viscera. A wound of the pleura is usually associated with a wound of the lung. Rupture of the lung or diaphragm may occur with little evidence of external injury (30). Hernia of the lung may develop quickly, or after a considerable interval.

SYMPTOMS

Generally speaking, there may be no symptoms. Pain, aggravated by deep breathing or cough, may occur over the site of the impending hernia during its development. In the author's case, no pain was experienced by the patient when the hernia became fully developed, but during the first week great pain was experienced,

first, from recovery from shock, secondly, pleural involvement, and, lastly, paroxysmal cough which was troublesome and increased the pain. Due to the bronchial fistula communicating with the pleural cavity, there was abundant expectoration. As a rule, however, with no pleural involvement, especially in the spontaneous pneumocele, the cough is hard, spasmodic, and unproductive. Early traumatic hernias are not detected, as a rule, since the signs and symptoms are masked by those of injury. Localized pain may be the first sign of hernia, verified later by a bulging mass the size and shape of which alter with respiration.

Distress caused by pulmonary hernia may consist of local pains during forced breathing and coughing spells. Pain may be pronounced at first, when the hernia suddenly develops, and later may disappear altogether. In cases of concurrent bronchitis, repeated hemoptyses have been observed. Several cases of this type, in which the symptoms have disappeared following treatment or operation, have been reported.

PHYSICAL SIGNS

The soft, crepitant, bulging mass in the chest wall, increasing in size during expiration, exertion, and cough and diminishing during inspiration, is pathognomonic of lung hernia. Montgomery and Lutz (27), Garré and Quincke (31), Lilienthal (32), Morriston Davies (33), Smith and Johnstone (29), and others describe these phenomena. These same respiratory signs were likewise observed in the author's case. The size of the tumor varies from that of a small egg to that of an orange, or baseball, and even larger; the pneumocele may be single or multiple, unilateral or bilateral, and may, or may not, be enclosed in a sac (29).

The orifice of the pulsating mass of lung is usually palpable and the bony or fibromuscular margins can be readily made out; its size, of course, varies with the size of

the protruding lung tumor. Due to a weakening of the chest wall, either a defect due to injury or of a congenital nature, sometimes a depression is seen during forced inspiration, wherein the tumor may actually retract and may be covered only by skin and a few strands of "thinned out" superficial fascia. It is readily reducible and recurs easily. When the hernia follows a wound caused by some penetrating instrument the lung is not covered by parietal pleura and consequently becomes adherent to the wound (31). If the wall of the tumor orifice becomes inflamed, adhesions may follow and the pneumocele may become incarcerated and irreducible. Although strangulation has been reported, Lilienthal considers this a very rare incident since the lung retracts readily because of its elasticity.

The pneumocele is usually covered by unbroken skin beneath which may be a few thin strands of fibromuscular bands; to the touch it feels soft, spongy, and smooth. Deese reports a lung tumor pedunculated and herniated and dark violet in color (34). In the writer's case the cavity of the pneumocele contained fluid and air, probably the first recorded instance, as no mention in the literature or text-books is made of this complication; two other fluid level pockets were also present. Reducing the mass by manipulation, one was able to penetrate the orifice of the cavity to a depth of about 3.5 centimeters. Most writers claim that the protruding, herniated lung can be grasped and readily recognized as lung tissue by its crepitant character. The lung tumor, as a rule, is tympanitic in note, and whistling; crackling râles may be heard while it is being held. Percussion elicits a peculiar tympanitic note and fremitus is usually increased. Pockets of emphysematous air in the subcutaneous tissues, when palpated, reveal the distinctive crepitation and crackling sounds with respiratory changes absent (34).

ROENTGEN SIGNS

Fluoroscopic observation reveals interesting phenomena during respiration. At the site of the hernial bulge only normal or increased radiance is visible in the anteroposterior position. In the lateral or oblique positions, on the tumor side, a bulging pocket of air can be noticed readily in the thoracic wall—the mass increasing in size, especially during forced expiration, muscular exertion, and cough. If it is not bound down by adhesions, the tumor mass can be reduced and held in place by several fingers over the palpable orifice, usually located between the ribs. A bony irregularity may sometimes be felt. If the bulging air pocket contains fluid, a fluid level can be observed which changes with position. In the oblique and lateral positions on the affected side an air pocket is seen in the thoracic wall with the *bulge greatest in forced expiration and smaller, flat, or retracted forced inspiration*. In the anteroposterior plane, at the site of the hernia, an area of increased radiance may be observed, the pleural cavity on the affected side containing fluid and air (author's case). A fluid level is present, the chest showing the usual homogeneous density. In the author's case, another fluid level pocket was recognized, probably behind the sternum, adjacent to the hernial bulge.

CONDITIONS CONFUSED WITH HERNIA

Among these conditions may be mentioned subcutaneous emphysema, empyema necessitatis, lung abscess, or pulmonary supuration perforating into the chest wall, tumors of the thoracic wall, pulmonary tuberculosis, caries of the rib, and gas bacillus infection. Bulgings observed about the clavicle in tuberculosis, with prolonged cough and emphysema, are not true herniæ, although occasionally hernia may develop in this region.

Subcutaneous emphysema may cause a



Fig 1 (top) Film made three days after the accident. There were noted, fracture of the ribs, ruptured pleura and lungs, right-sided pyopneumothorax, and extensive interstitial emphysema

Fig 2 (bottom) Three days after the accident. Note the extensive interstitial emphysema

bulging in the chest wall. In crushing injuries of the thoracic wall in which the soft tissues are involved, small affected areas may coalesce. These are crepitant on palpation, tympanitic in note, with audible and readily displaced bubbles of air. Gas bacillus infection may simulate this condition and sometimes masks the picture, but no phenomena occur with respiration (35, 36).

A puncture wound, traumatic or operative, may sometimes give rise to this condition. Subcutaneous emphysema commonly follows paracentesis of the chest; it also sometimes follows trauma or a violent

coughing paroxysm and is often seen over the lower part of the neck and manubrium. It may occur in influenzal pneumonia, often spreading over the chest and abdomen. In empyema necessitatis, a bulging external tumor may simulate hernia; the tumor may increase or diminish in size during coughing or forced breathing. To differentiate tumors of the chest wall from hernia, dependence must be placed on the presence or absence of crepitation and the other signs commonly found in hernia. One case of tuberculosis is cited in which ulceration had destroyed a portion of the intercostal muscles, leaving only the skin and subcutaneous tissues covering the lung; during inspiration and cough there was a distinct bulging but the tumor mass lacked the characteristic crepitation of hernia (1).

My thanks are due Dr. Andrew J. Brislen for his many valuable suggestions and for the privilege of reporting the following case. I wish also to convey my thanks to Dr. Carl Hedblom, to whom I cited the history of the reported case and who viewed the roentgenograms. To Dr. James G. Montgomery, of Kansas City, Missouri, I am equally grateful for his expression of opinion by correspondence.

SUMMARY

A brief history of lung hernia is cited and Morel-Lavallée's classification is recorded. The anatomic considerations, the symptoms and the physical signs are enumerated. The respiratory phenomena as observed in the protruding lung hernia may be considered pathognomonic. Finally the roentgen signs are described and evaluated. The author's personal case is appended.

CASE REPORT

W. N., a mechanic, was admitted to Woodlawn Hospital on Sept. 30, 1931, with a clinical diagnosis of crushing injury to the right chest. Three days previously his car

had turned completely over. The man was picked out of the wreckage, severely injured, and taken to a neighboring hospital where he remained several days. Becoming dissatisfied, he boarded a train for a 14-hour journey to Chicago. He was admitted to Woodlawn Hospital on the afternoon of his arrival in the city.

Physical Examination.—The patient, a male, age 42 years, weight about 140 pounds, was in extreme pain and grunted with each respiration. He assumed a crouching position; his face was a dusky hue. Labored respirations, 32; temperature, 101.4; pulse, 108. Subcutaneous emphysema existed in a marked degree from the lower jaws to the iliac crests. In the proximity of the third rib, on the anterior chest wall, a small, superficial wound, 2.5 cm. in length, and a contused area, 5 cm. in diameter, were seen. The right second intercostal space anteriorly was depressed, but bulged somewhat on expiration. The heart was dextro-displaced 2.5 centimeters. Subsequently this was ascertained to be due to a moderate degree of scoliosis. Respirations were somewhat superficial and labored; when deeper, dyspnea and excruciating pain were present. Cough with expectoration of a bloody type was present. No cyanosis existed but the patient did not seem any too well aerated.

Chest.—The right thorax was tender to palpation and percussion, particularly anteriorly. Dullness on percussion was present over the lower half of the chest, both anteriorly and posteriorly, with absence of fremitus. A distinctly tympanitic area, most marked between the anterior and posterior axillary lines, superimposed on the dull area, was noted. On auscultation, breathing sounds were bronchial in character and intensified, these conditions being most marked over the right upper thorax; here numerous moist râles were heard. Breath sounds

were absent over the lower half of the right chest.

X-ray Examination.—Sept. 30, 1931. Upper thorax: there was definite pathology involving the entire right chest with the exception of the extreme apex, which showed marked infiltration of the soft tissues with air. The soft tissues of the anterior chest wall and in the region of the axilla as far down as the tenth rib showed cutaneous emphysema. Owing to the scoliosis in the lower left dorsal vertebræ, much of the shadow of the right heart was seen; the heart was, however, in its normal position. There appeared to be angulation of the ribs from the second to the fifth, inclusive, in about the anterior axillary line in comparison with the corresponding areas of the left side. This was indicative of fracture. The lower three-fourths of the right chest was occupied by a dense, homogeneous shadow through which were seen irregular areas of air mingled with areas of emphysema in the soft tissues of the chest wall. This shadow obliterated the diaphragm and the costophrenic angle. Lower thorax: The emphysema had invaded the soft tissues of the left lumbar region. There was marked scoliosis in this region which caused a deformity of the lower ribs, but there was no evidence of any fracture.

Summary.—Upper thorax: multiple fractures to the right anterior ribs; fluid in the right pleural cavity; injury to the right lung; cutaneous emphysema in the right chest wall; traumatic pneumocele of the right lung; old scoliosis. Lower thorax: cutaneous emphysema (Figs. 1 and 2).

From these findings the following diagnosis was made:

1. Contusion and small lacerated wound of the right anterior chest wall with destruction of some of the intercostal tissues at the second and third ribs.
2. Multiple fractures of the right anterior ribs.

3 Injury to the right lung, inducing bronchial fistula, open pneumothorax, and hemothorax

The cough persisted, though it was better controlled after the first few days. The hemoptysis gradually subsided until approx-

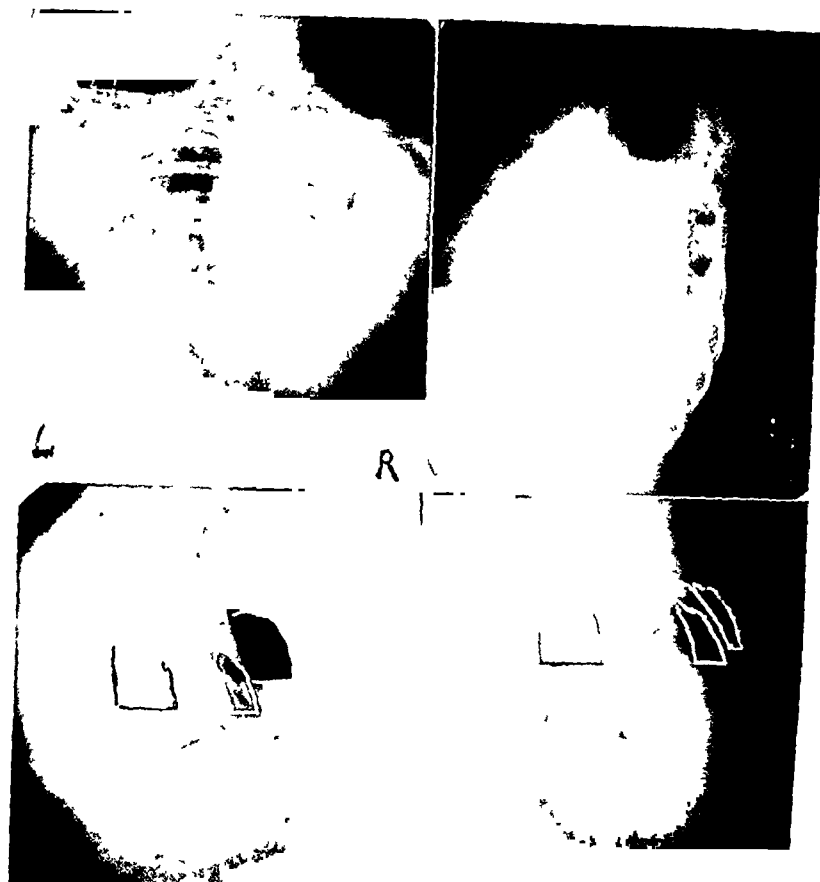


Fig 3 (*upper left*) Erect position. Note the large, right pyopneumothorax and the two fluid levels.

Fig 4 (*upper right*) Right lateral recumbent position. Note the two fluid levels in the upper lobes and the third in the pleural cavity. The largest cavity in the upper lobe corresponds to the bulging on the right anterior chest wall at the second interspace.

Fig 5 (*lower left*) Forced expiration, lateral, right. Note the large pocket in the anterior chest wall and behind the sternum, also the third pocket and fluid level in the pleural cavity.

Fig 6 (*lower right*) Forced inspiration, lateral, right. Note the collapsed pocket on the anterior chest wall.

4. Subcutaneous emphysema extending from the lower jaws to the iliac crests

5. A pulmonary hernia

Course and Progress —The dyspnea and the chest pain improved after a few days

imately the *fifteenth* day, when it ceased to be a factor. The expectoration varied from purulent, blood-tinged to clear mucus through the subsequent course. During the first week the bulging in the region of the

second and third ribs increased, attaining approximately the size of a baseball, growing smaller with inspiration, but exceedingly

It may be well to note the fact that aspiration of 915 c.c. of pus with the replacement of an equal amount of air was done on



Fig. 7 (*upper left*) Erect position. Large right pyopneumothorax. Note the pocket of second fluid level at the second anterior rib.

Fig. 8 (*upper right*) Right anterior oblique (erect). Note the two fluid levels.

Fig. 9 (*lower left*) Forced inspiration, lateral. Right lateral erect position. Note the three fluid levels.

Fig. 10 (*lower right*) Right lateral recumbent position. Note the fluid level of the pyopneumothorax.

tense and larger with expiration and cough. A pad of the hernial type was strapped over the lesion, compressing the hiatus between the second and third ribs, with a visible improvement in comfort to the patient. Irregular temperature of a septic type persisted through the six weeks of hospitalization, declining during the last 10 days to a practically normal temperature.

October 22, at the time of the lowest white count. A direct smear showed numerous pus cells, but no organisms. Incubation of 76 hours showed no growth.

X-ray Examination.—Oct 12, 1932. The lower one-half of the right chest was occupied by a dense, homogeneous shadow obliterating the ribs, diaphragm, and costophrenic angle, and showing a definite hori-



Fig. 11. Erect position. There is absence of fluid in all pockets. The entire right chest is re-expanded except for residual, thickened pleura and high diaphragm at the right base.

zontal level. With agitation, definite fluid waves were seen. An oval shadow of rarefaction, which corresponded to the bulging air pocket in the anterior chest wall, was seen above this level. With the patient in the right lateral recumbent position, examination revealed considerable pneumothorax with three definite fluid levels, the one of the pneumothorax; the second, the pocket of air and fluid on the anterior chest wall, and the third, a pocket of air and fluid beneath the second portion of the sternum. Lateral views showed that forced inspiration and expansion of the chest wall caused diminution in size of the air pocket on the anterior chest wall. With forced expiration of air the chest was contracted, the external pressure relaxed, and the air pocket in the anterior chest wall bulged. The area of interstitial emphysema seen in the soft tissues of both necks, the anterior chest wall, and the abdomen had considerably diminished since the first examination. It was difficult to

establish the communication between the pockets of air in the chest wall and the pneumothorax.

Summary.—Diminution of interstitial emphysema; large hydropneumothorax; localized pocket of air and fluid on the right anterior chest wall in the region of the second and third ribs; pocket of air and fluid behind the midportion of the gladiolus (Figs. 3, 4, 5 and 6).

X-ray Examination.—Nov. 2, 1931. There was an increase in the homogeneous shadow of the right chest from the second anterior rib to the base, obscuring the diaphragm, lower ribs, and costophrenic angle. The amount of the pneumothorax in the pleural cavity had diminished although there was an increase in the amount of fluid in the chest. The pocket of air beneath the right clavicle on the anterior chest wall had considerably diminished and was seen along the anterior wall of the chest. The pocket of air behind the sternum was likewise considerably smaller.

Summary.—Increased right pyopneumothorax; interstitial emphysema along the anterior chest wall (Figs. 7, 8, 9 and 10).

As a result of this report, the patient was sent to the operating room on November 4 for thoracotomy. He expectorated a considerable quantity of purulent material while on the table. Because aspiration through the sixth, seventh, and eighth intercostal spaces in the posterior axillary line proved negative and percussion resonance seemed better than the roentgenogram indicated, the operation was discontinued.

The temperature gradually subsided and the general condition and cough became much better. On November 11 the patient left the hospital in good general condition. His temperature was 99, pulse 110, and respirations, 20.

X-ray Examination.—Nov. 24, 1931. Re-examination revealed a complete absorp-

tion of fluid in the right pleural cavity with almost complete expansion of the entire right lung with the exception of the right base. The diaphragm here was still elevated but showed a fairly good excursion, al-

pansion of the right lung; residual pathology at the right base with thickened pleura (Fig. 11).

Physical examination at this time revealed a good respiratory sound and reso-

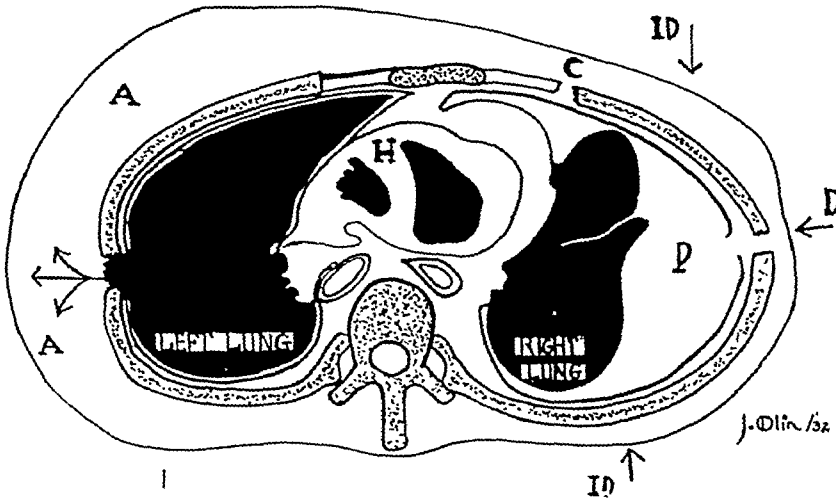


Fig. 12. Diagrammatic cross-section of thorax to show the mode of production of pneumothorax or hemothorax and of subcutaneous emphysema as a result of fracture of the ribs. *ID*—The arrow shows the line of application of indirect force in producing fracture of the ribs. *D*—Line of application of direct force in producing fracture of the ribs. *P*—pneumothorax as a result of fracture of the ribs and laceration of the pleura on the right side. *A*—extensive subcutaneous emphysema as a result of puncture of a lung by the sharp ends of a fractured rib fragment. The triple arrow shows the mode of egress of the air from the punctured lung into the subcutaneous tissues. *H*—cross-section of the heart. *C*—fracture at costochondral junction without displacement.

From Keen's Surgery, Vol. II, p. 159.

though not so deep as on the left. The several pockets of air and fluid which had been seen on the previous examinations had disappeared. In the right chest there was still some irregular mottling at the base, residual of the infection, associated with thickened pleura. The markings as a whole were accentuated, with a band of thickened pleura seen in the third right anterior interspace. The trachea and heart were in normal positions, but the mediastinal shadows showed definite root thickening, undoubtedly associated with the previous pyopneumothorax.

Summary.—Obliteration of several pockets of air and fluid; complete absorption of interstitial emphysema; restoration of ex-

nance down to the region of the sixth rib in the axillary line and the eighth rib in the posterior scapular line. The patient coughed rarely. He had been going out of doors for a week, his appetite was good, and his general strength was returning. When he was seen last on November 30, he had no complaints. He was sent back to resume work.

Binney is of the opinion that lung injury by sudden pressure or rupture by the sharp end of a fractured rib will usually cause hemothorax and some degree of pneumothorax, hemothorax, or both. If pneumothorax is present, sooner or later signs of cutaneous emphysema of the chest wall may appear (37).

DISCUSSION

The noteworthy feature in this case was the presence of a protruding mass or bulging of the anterior chest wall, the size of a baseball, in the region of the second and third ribs. The mechanism of such a crushing injury is interesting and one is puzzled to learn the extent of damage to the thoracic viscera. The presence of a bronchial fistula was demonstrated by hemoptysis from the third to the fifteenth day until it gradually subsided, associated with attacks of a violent, persisting cough and the expectoration of sticky, yellow, tenacious material. The fistula and the bulging chest mass gave proof of the presence of an open pneumothorax and a hemothorax. Emphysema of the skin or evidences of hemo- or pneumothorax are positive signs of a fracture of the ribs (38). The multiple fracture of the ribs evidently tore the lungs and pleura to such an extent as to cause hemorrhage into the pleural cavity, allowing the escape of air from the injured lung into the subcutaneous tissues of the right and left neck, chest wall, and abdomen. After a lapse of six or seven days, the hemorrhage ceased and the rent in the lungs became sealed with pleural exudate. With laceration of the soft tissues of the anterior chest wall, the pleura, covered only by skin and a thin layer of superficial fascia, protruded through the opening in the chest wall.

At about the end of the third week I observed the exact location of the bulging mass and the effect upon respiration. (I previously had examined the patient several times under the fluoroscope and had made plates in various positions on each occasion.) Palpation revealed a distinct hollow in the second rib, due to loss of tissue. With inspiration, the mass became smaller; after expiration it bulged outwards, and was the size of a small orange. Fluid was easily detected in the bulging mass. The contents seemed to be a viscid, sticky material and compressed, crepitant tissue.

I am not able to determine how long the lung punctured by a broken rib may pump air with every respiration into the tissues, although fifteen days after the accident the emphysematous air was slowly being absorbed and considerably less was present than on the day of admission. Since this mass was visibly affected by respiration, the pertinent question arises: what were the layers of tissue comprising this mass? That this external chest wall pocket communicated with the pleural cavity is evident from the nature of the phenomena occurring during respiration. One attempt at solution would explain this pocket as a purely external cavity filled with air and fluid. During the height of a full inspiration with the lungs completely expanded and the thoracic cage increased in volume to accommodate the increased lung volume, the external chest wall pressure would be sufficient to compress the pocket. Conversely, at the height of a full expiration, the full compression of the thoracic cage and its contents would permit complete relaxation upon the cavity, which would cause it to bulge. This mechanism is fully brought out by Figure 12 and is applicable to the cause and formation of subcutaneous emphysema and pneumothorax complicating rib fracture. On inspiration, the lung expands and air rushes into the pleural cavity; on expiration the lung collapses and the rent in the lung tissue is closed so that withdrawal of air from the pleural cavity becomes impossible. This phenomenon probably occurred within from seven to ten days following the accident. That the mass connected with the pleural cavity is obvious, in that respiration changed its form and size. If no communication of the pocket existed with the pleura, no expansion and retraction would occur other than moderate tension of an expanded chest against the wall of the cavity.

With pyopneumothorax present, the bulge essentially amounted to a hernia of the lung. According to most text-books, hernia of the

lung occurs most commonly anterolaterally in the chest, and there may or may not be a layer of parietal pleura. In cases of long standing, because of the adhesions to the overlying tissues, the hernia may be irreducible. The hernial sac under discussion, however, was readily reduced and held in place by a circular cardboard over its orifice. Lilienthal claims that in true hernia only a small amount of lung extrudes and strangulation rarely happens as the lung tissue is so easily compressible (32). To quote further: "There is a tendency for the tumor to decrease in size during *inspiration* and sometimes to protrude with ordinary *expiration*; cough will cause the tumor to become tense." This author, quoting from Sauerbruch, states that, if the reverse phenomenon occurs—bulging on inspiration and retraction on expiration—a complication of diaphragmatic injury with prolapse of abdominal viscera into the thorax and out through the chest wall may be suspected.

SUMMARY

A severe crushing injury of the chest complicated by lung hernia, three fluid level pockets, pyopneumothorax, and extensive subcutaneous emphysema of the chest wall and abdomen resulted in apparent recovery, full re-expansion of the lung, and closing of the hernial sac without operation. The withdrawal of 915 c.c. of pus, followed by replacement with an equal amount of air, and expectant treatment, were sufficient to alleviate fully the condition in seven weeks following the extensive injury.

Since this writing, we have received word that the bulging in the chest wall has recurred, although the patient is attending daily to his duties as an automobile mechanic. He has promised to pay a visit to his physician but has not reported up to the present time (March 15, 1932).¹

¹ Patient was seen again in June and appeared in good health. The bulging mass had disappeared entirely and the chest, other than the thickened pleura at the right base, appeared normal.

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THE TERMINAL ILEUM, CECUM, AND ASCENDING COLON FROM THE STANDPOINT OF THE ROENTGENOLOGIST¹

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THIS discussion is based on findings in 10,000 colon fluoroscopies, studied with the clinicians at Presbyterian Hospital and Rush Medical College. It is my good fortune in x-ray work to be very closely associated with the clinicians. Seldom is a fluoroscopy done without the presence of the patient's attending physician, his interne, and often medical students. In case the physician cannot be present, he communicates with the roentgenologist. We study the fluoroscopy and films together and discuss the pros and cons of the x-ray findings in the light of the patient's clinical condition. This arrangement has been of inestimable value to patient and doctor.

PREPARATION OF PATIENT FOR COLON EXAMINATION

The psychologic preparation of the patient should be stressed. A few words of explanation and assurance given to patients, particularly to those who are apprehensive, before they enter the dark room, help a great deal. The patients relax better and are easier to examine.

We like to have the bowel emptied by the use of one or two one-quart enemas. Not less than two hours should elapse after the last enema before the fluoroscopy. If the patient has diarrhea, no preparation is needed. Medication which irritates the bowel produces spasm and may lead to a faulty diagnosis. Proctoscopy should not be done less than two hours previous to fluoroscopy, because of the air that enters the bowel and the relaxation of the anal sphincter which occurs.

TECHNIC

A barium enema, composed of one part of barium sulphate to three parts of water warmed to body temperature, and well stirred, is the usual contrast medium employed in x-ray examination of the colon. The enema can is placed three feet above the patient; the flow is regulated by a bulldog clamp on a soft rubber tube leading to a sterilized hard rubber enema tip, three inches long. The air is expelled from the hose. We tell the patient, "We are going to give an enema which we can watch as it goes in. If it causes pain, tell us, and we will stop it."

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

We first fluoroscope the chest and abdomen. The enema is then injected slowly, under fluoroscopic control, until the colon is filled, or until the patient complains of pain. If there is pain, we stop the enema or decrease the flow by compression of the tube, and tell the patient to take deep breaths. As the pain subsides, we continue the enema, and so on, until barium passes into the small bowel, which is our signal that the colon is completely filled. If the pain does not subside or barium does not progress, we stop the injection. Except in cases with an obstructive process, the colon can usually be filled by a little persistence and without much difficulty or distress to the patient. As the colon fills, we turn the patient to left and right and palpate the abdomen in order to visualize all parts of the colon, to uncover or straighten out redundant loops, to test the mobility and pliability of the bowel, and to elicit any areas of tenderness. If there is pain, we try to determine if the patient's typical distress is reproduced; if it is localized to the colon, or is increased by the enema or by palpation. Any palpable masses are studied in their relationship to the bowel. We always look for an appendix and palpate in this region for tenderness.

Occasionally the examination is by means of a barium meal followed through the small bowel and colon by repeated fluoroscopic examinations. This method of examination is dangerous if the patient has clinical signs of obstruction. In this case, the patient should be carefully watched and given mineral oil by mouth, and enemas as necessary. Drastic cathartics or irritating enemas should never be given.

NORMALS AND VARIATIONS OF NORMAL

Normally the barium enema passes readily into the colon and fills it uniformly and completely, with little or no pain to the patient. Moderate haustral indentations are visible along the bowel margin, except in the

rectum. In my experience, barium passes into the terminal ileum in nearly all cases in which the cecum can be filled. Occasionally, with the colon well filled, no barium passes into the small bowel. This finding should be checked by barium from above. If nothing else is found to account for it, either roentgenologically or clinically, then the fact of valve competency is of no significance.

During fluoroscopy, one sees many variations in length, redundancy, and position of the colon, as a whole or in part, even to complete transposition (*situs inversus*).

Ptosis of the colon, as that of the stomach, may be so marked, especially in thin women, that the greater part of the colon appears to lie within the bony pelvis, which is normal for that type of individual; or the colon normally may extend to or above the costal margin in the short, heavy-set type of individual.

The capacity of the colon normally varies considerably in different patients. For example, from one to four quarts of fluid is required to fill the bowel, the average capacity being about one and a half quarts.

These are anomalies, depending either upon incomplete embryonic descent and rotation of the hindgut, or upon the habitus of the patient. Human beings vary as much on the inside as they do on the outside and many variations exist which are well within the range of normal.

Of course, malpositions which are pathologic may occur: for example, the projection of a loop of bowel into a hernial pouch, or displacement by extrinsic pressure, as from a large liver or spleen, a big kidney, a mesenteric or ovarian cyst, a large fibroid or a pregnant uterus, enlarged mesenteric glands, etc.

Although pathologic variation in size or position, occurring from adhesions, membranes, bands, or kinks, is fortunately not common, when present, it is of great significance. In my experience, if the colon

fills to normal size and has a reasonable range of mobility, that is, from two to three inches, it has no significant adhesions. Any apparent angulation of the colon, which looks like a sharp kink, particularly if an air bubble is present, should be examined by turning the patient, or by manipulation. By this means, it is often shown to be only a curved segment of normal sized bowel.

COLON PATHOLOGY

In this discussion of pathologic changes I shall omit the x-ray diagnosis of appendicitis since it is being discussed by another.

Probably the lesion most easily recognized by means of the barium enema is the "napkin-ring constriction" of the lumen or the irregular filling defect so characteristic of carcinoma. The area of the deformity corresponds closely to the size of the tumor. After the sigmoid, the cecum is the most common site of carcinoma of the colon, although any part of the bowel may be involved.

Case 1. A patient had a filling defect about two inches long in the upper end of the ascending colon near the hepatic flexure. On the first examination the colon filled normally up to that point; then the patient had great difficulty in retaining the enema and the barium did not penetrate further. Two days later, on re-check examination, barium passed through the area of constriction, filled the cecum, and some passed into the small bowel. The area of napkin-ring deformity did not fill. In addition to this constriction, there was considerable spasm associated with the lesion. One of the films showed most of the barium cramped out of the transverse colon, while on another film this region was well filled. Both films recorded the constricting defect. There was a tender, palpable mass at the site of the constriction. The clinician stated that the patient had been losing weight and that blood was found in all stools examined. Considering the type of filling defect and the pa-

tient's history, carcinoma seemed the most probable diagnosis. This was confirmed at operation.

Case 2. Clinically the lesion of this patient was diagnosed as carcinoma of the colon. Prior to surgery, the patient was referred to the roentgenologist for the exact localization of the lesion. The barium enema entered the bowel readily, filled the rectum and rectosigmoid normally, and then passed through an irregular constriction of the sigmoid 3 inches long. Beyond this the rest of the colon filled to a little larger than normal size to the upper part of the ascending colon, where it stopped completely. The margin of this obstruction was irregular and somewhat pointed at each edge. I wondered if this patient could possibly have two carcinomas in the colon, since both defects resembled those frequently seen in carcinoma. The operation showed a large, definite, annular carcinoma at the site of the defect in the ascending colon. Gravitation metastases produced a compression deformity of the sigmoid colon, which, when freed from this mass, appeared normal.

Sometimes the filling defect of carcinoma is not easily recognized either fluoroscopically or on a film, particularly if it is an early lesion and of small size.

Case 3. On fluoroscopy of another patient the colon filled well, except that no barium passed the ileocecal valve and the mesial margin of the cecum was somewhat concave. Barium given by mouth passed readily through the small bowel and colon in normal time. However, there was an irregularity of the barium outline in the cecum at the ileocecal junction and the terminal inch of the ileum was narrowed. On reviewing films made elsewhere a year previously, this same deformity was visible, except that it was smaller and a little less definite. In the year's interval, the patient's attacks of pain had continued and had gradually become worse. The presence of a mass the size of a walnut in the right

lower quadrant and the rhythmic character of the pain, which suggested a small bowel obstruction, were the clinician's reasons for requesting an x-ray study of the colon. The fact that the same defect was present on films made on two examinations a year apart was very significant, and, together with the history, led to the diagnosis of carcinoma. This was confirmed at operation, the cecum resected, and a lateral anastomosis done.

A year post-operatively, barium passed readily into the small bowel at the site of the anastomosis. This fact calls our attention to deformities of the bowel, which, when seen fluoroscopically, should lead the roentgenologist to inquire as to any previous operations.

Case 4. The patient's colon filled readily to normal size throughout. Barium passed the ileocecal valve to fill and distend the terminal inch of the ileum, and then stopped abruptly, with a somewhat irregular contour. The film showed, in addition to the defect, two air-filled, distended loops of small bowel. These findings, which speak for an obstructive process in the terminal ileum, closely resemble the findings of Case 3. The history revealed, however, that this patient was operated upon five years earlier for carcinoma of the uterus, that she had been symptom-free until recently when she began to have pain and distention in the abdomen, and, in the last few days before the present examination, definite signs of intestinal obstruction. Carcinomatosis was found at operation, with many nodules in the mesentery and peritoneum. Several loops of small bowel were adherent to the anterior abdominal wall. A band of adhesions as thick as a finger closely bound the terminal ileum, producing obstruction and the defect which was seen roentgenologically. This band was severed and drainage established. The patient died 10 days later.

Case 5. The patient, a diabetic, was roentgenographed because of pain in the right lower quadrant, associated with a

palpable mass and an elevation of temperature. Extensive tuberculosis of the left lung was evident on a film taken six years previously. Formerly there had been many tubercle bacilli in the sputum, though recently the chest condition had seemed less active, clinically.

Fluoroscopically, the barium enema filled the colon readily to good size throughout. The transverse colon was long and redundant, the cecum markedly spastic. No barium entered the small bowel. There was extreme tenderness over the cecum.

On re-check a few days later, after the pain had somewhat subsided, a barium meal passed through the small bowel and colon in normal time. There was a small area in the cecum, near the ileocecal valve, which did not fill well. Palpation gave the impression that it was caused by a mass posterior to the cecum. This finding remained constant and corresponded to the findings noted during the previous fluoroscopy. The film taken after the barium enema showed a curved depression on the mesial side of the cecum.

A tender spastic cecum, in a patient with known pulmonary tuberculosis of rather long standing, spoke strongly for a tuberculous bowel. An associated mass suggested tuberculous glands in the mesentery or peritoneum. Against this diagnosis was the rather sudden onset of symptoms, exquisite tenderness, and the fact that the mass was apparently single and fairly large and globular, instead of the multiple, firm, tender nodules usually found in tuberculous glands.

A few days later the mass disappeared spontaneously, and the patient's pain and temperature subsided. The clinician's diagnosis was then ovarian cyst, probably a corpus luteum cyst, which had ruptured.

Case 6. The x-ray film and the fluoroscopic findings of the right side of the colon of this patient were almost duplicates of those in Case 5. The palpable mass in the abdomen was irregular and only moderately tender. Small firm nodules were pal-

pable in the neck, axillæ, and groins. His chest film was negative for tuberculosis. The hilus shadows were heavy and somewhat nodular in outline, very suggestive of enlarged glands. This 53-year-old man was weak, anemic, and had lost 15 pounds in weight in the six weeks preceding this examination.

When the x-ray findings of the colon and chest were associated with the clinical evidence, we could rule out both tuberculosis and cancer, and diagnose lymphosarcoma. X-ray treatment helped temporarily, though not for long. As a terminal condition, both ureters became occluded by the abdominal mass. The diagnosis of lymphosarcoma was confirmed both by section of a gland and by postmortem examination.

SPASM

Spasm, or intermittent contraction and relaxation of the colon, may be sufficient to cramp all the barium out of a large segment of the bowel. It is usually accompanied by considerable pain and marked desire to go to stool. In the intervals of relaxation, the bowel fills to normal size. Barium usually passes into the small bowel somewhat in proportion to the degree of spasm.

Spasm of the right side of the colon may be a part of the generalized spasticity of a functionally irritable colon, or a toxic colitis. Occasionally the spasm occurs in attacks with pain so severe as to necessitate morphine for relief, and so localized as to simulate appendicitis or a kidney or gallstone colic. If, however, the patient's typical pain can be reproduced by filling the bowel, and we see fluoroscopically that the site of the pain is in the position of the colon, and does not correspond exactly to the suspected area (kidney, gall bladder, etc.), if the genito-urinary and gall-bladder films are negative, and the history is that of a bowel disturbance, we have come a long way toward establishing the diagnosis. On the other hand,

spasm may occur only, or chiefly, on the right side of the colon, due to intrinsic causes, the most usual being tuberculosis or amebic dysentery. Likewise, spasm may occur reflexly from extrinsic causes, such as an inflammatory process of the appendix, gall bladder, or kidney, a pelvic or psoas abscess, pyosalpingitis, or similar conditions. The differentiation may be difficult, although a correct diagnosis may usually be established by consideration of the history, all the clinical and physical findings, and the x-ray evidence.

Case 7. In one case, localized spasm simulated the napkin-ring deformity of carcinoma. The rest of the colon filled well, but neither by palpation, turning the patient, having her take deep breaths, nor by introducing more barium, could I change the aspect of this deformity. The area was only moderately tender and no mass was palpable. Clinically no evidence suggesting carcinoma had been found. Both the attending physician and I were at a loss to explain this finding. We thought the fluoroscopy should be re-checked and the clinical evidence reviewed for possible carcinoma. Two days later, the examination of the colon showed no evidence of this constriction.

Case 8. The patient was a healthy looking man, 50 years old, who complained of intermittent diarrhea of five years' duration. The barium enema filled his colon readily to good size up to the ascending portion, at which point intermittent spasm was seen, although there was none elsewhere. The patient experienced moderate distress from the enema. The film showed a definite, irregular constriction of the cecum and lower part of the ascending colon, suggestive of carcinoma. Fluoroscopically, carcinoma was easily ruled out because of the intermittent filling and emptying and the absence of a palpable mass. The proctoscopic examination revealed ulceration in the lower bowel and the stools contained motile amebæ.

Case 9. In another case, the colon fluoroscopy showed only spasm, yet it helped to settle the diagnosis. While in the country, a boy of 8 years had had an acute attack of right abdominal pain, with high temperature and vomiting, associated with rigidity and tenderness in the right lower quadrant. A local physician very logically diagnosed appendicitis, and advised immediate operation. The parents, however, remembered several similar previous attacks and hurriedly took the boy to their home physician. The boy was placed in the hospital, and, after a few days of rest, plenty of fluids, some alkalies, and a light diet, the attack subsided. In the meantime the colon was fluoroscoped and found negative except for slight spasm, mostly on the right side, and some tenderness of the bowel on pressure. The site of the recent pain did not correspond exactly with the position of the appendix, which was well filled and easily movable. This ruled out appendicitis. With the favorable response to treatment, the pediatrician's diagnosis of allergic reaction of the bowel was confirmed.

EXTENSIVE NARROWING OF LUMEN: ULCERATIVE COLITIS

Case 10. Here is a case, first examined in 1925, in which the diagnosis can be made with a considerable degree of certainty from the x-ray examination alone. The descending colon and the distal portion of the bowel filled as a narrow channel an inch in width. There was little evidence of haustral markings. The proximal portion of the transverse and the ascending colon filled to normal size. The patient complained of only moderately severe distress from the enema. The film confirmed the fluoroscopic findings and was quite characteristic for an ulcerative colitis. That diagnosis also fitted the clinical evidence of pus and blood in the stool and ulcers in the lower bowel, visible proctoscopically.

In spite of treatment, including colostomy, the condition persisted and progressed. A film made in 1928 showed marked narrowing of the transverse and descending portions, with a fair filling of the ascending colon. In June, 1931, the colon filled almost as soon as the enema was started, and a considerable amount of barium came out through the colostomy. Barium entered the small bowel also. The film made at that time showed the lumen of the colon to be about the size of a drinking straw throughout and very much shortened. Clinically, the patient was comfortable, and wanted her colostomy repaired. Needless to say, this was not done.

Sometimes there are one or more groups of small, rounded areas of decreased density in the barium filling which resemble small polypoid projections into the lumen of the bowel. This condition is due to a papillary hyperplasia of the mucous membrane of the colon, which develops in the region of a chronic inflammation in the bowel wall. This condition, which may be extensive or localized, is a complication of ulcerative colitis.

Case 11. In this patient, the condition, which was present throughout the transverse and descending portions of the colon, was associated with a marked ulcerative colitis. We were unable to fill the bowel completely because of severe pain and spasm. An outstanding clinical feature of this case was repeated attacks of severe bowel hemorrhage.

Case 12. Another patient's condition clinically strongly simulated a carcinoma. He became severely emaciated, weak, and anemic, and there were pus and blood in the stool. A single group of multiple round areas of decreased density were seen in the lumen of the descending colon, serving to differentiate the lesion from carcinoma and establish the x-ray diagnosis of localized papillary hyperplasia. The rest of the bowel filled to somewhat larger than normal size.

with a smooth lumen somewhat lacking in haustral indentations. The postmortem diagnosis was localized papillary hyperplasia in conjunction with ulcerative colitis.

LESIONS WITHIN THE LUMEN: POLYPS

Sometimes one finds a single rounded or slightly loculated filling defect in the lumen of the bowel, which suggests an air bubble or a fecal mass. The bowel fills well and is pliable except that this same air-bubble type of defect is reproduced each time pressure is made in that region, or it is seen without palpation, if it is large enough. In the event that these findings persist on re-check examination after enemas, the diagnosis of a polyp is practically certain.

The clinician is usually searching for a source of unexplained, persistent, or intermittent blood in the stool. There may be little or no distress. A mass may be palpable, or only questionable, or not found until after it is localized by x-ray examination.

Case 13. A polyp is usually localized to a certain area; in one case, however, it could be pushed along from the cecum to the hepatic flexure. Each time we worked it up to the hepatic region, it slipped away and fell back to the cecum. At operation, there was found a polyp on a very long pedicle attached close to the ileocecal valve. A large polyp located in the cecum may prevent the reflux of barium into the small bowel.

INTUSSUSCEPTION

In cases of intussusception, the bowel fills normally except that, in the cecal region, the barium appears to be displaced by a large air bubble which prevents the enema from entering the small bowel. This spurious air bubble, which is due to the invagination of the terminal ileum into the cecum, varies in size with the degree of invagination. The defect is persistent unless one is fortunate enough to reduce the intussusception by

manipulation, in which case the x-ray findings return to normal.

A large polyp in the cecum and intussusception look remarkably alike roentgenologically, and may be confused. With intussusception, however, there is usually an acute, prostrating pain in the right lower quadrant, which remarkably simulates appendicitis. Intussusception is most often seen in children, although both types of lesions may occur in either children or adults.

DILATATION OF BOWEL LUMEN

Sometimes the lumen of the large bowel is dilated to several times its normal size, either in some segment of the bowel, or through its entire extent. Such a dilatation occurs in the congenital idiopathic condition known as megacolon, or Hirschsprung's disease. In the localized type, the dilatation, which roentgenologically is usually an abrupt change from the normal size, is most often in the left or distal portion of the colon. Barium is usually retained in this segment after it is evacuated from the rest of the bowel. In very severe grades of this disease the dilatation may involve the entire large bowel.

The dilatation of an atonic bowel, such as is sometimes seen in aged or debilitated patients, or those addicted to the enema habit excessively, is not, as a rule, so marked as in megacolon. Although generalized, the dilatation is more pronounced in the proximal part of the colon, especially the cecum and ascending colon. The bowel usually will empty fairly well. The normally large bowel, sometimes seen even in children, usually has good muscle tone and will empty readily. In each case the history and clinical findings are of importance in establishing a correct diagnosis.

Case 14. The patient, a young man, stated that his bowel movements had been infrequent since childhood, and that for several years preceding the present examina-

tion, he had taken an enema of 10 quarts of water about once a week, and had thus succeeded in obtaining a bowel movement. His original film was a 10×12 one, and, therefore, the diameter of this air-filled segment of the bowel shown on it must have been at least eight inches.

LESIONS PROJECTING BEYOND BOWEL MARGIN; DIVERTICULA

Occasionally, on filling the bowel of a patient 40 years old or over, a small round shadow projects beyond the bowel margin, either with or without a pedicle. Its size may vary from that of a pinhead up to 2 cm., rarely more. It is a diverticulum. Diverticula, which are usually multiple, are most often located in the sigmoid, or are more numerous there if they extend to other parts of the bowel. Occasionally, diverticula are limited to the right half of the colon, or a single diverticulum may be present near the hepatic flexure. Diverticula often remain filled with the opaque material for a considerable time after it passes out of the rest of the bowel. This may lead to confusion, and necessitate differentiation from other conditions, such as barium retained in contracted haustra, stones in the gall bladder or urinary tract, phleboliths, or calcification of mesenteric glands, psoas abscess, fibroids, or ovary. The differentiation is usually made by filling the bowel, visualizing the diverticulum, and pushing it away from the area in question.

INFREQUENT OR UNUSUAL CONDITIONS

One must always be on the lookout for rare or unusual conditions. Foreign bodies are sometimes a cause of abdominal pain or of obstructive symptoms, especially in children, since they are so apt to swallow coins, small toys, etc. Adults sometimes swallow a foreign body or, unfortunately, a foreign body may be left in the abdomen

at operation, or introduced at the time of an injury, such as an automobile accident.

The pain of pneumonia, especially in children, may be referred to the right side; it may simulate appendicitis, or gall-bladder or kidney-stone colic, or, more rarely, some other intra-abdominal condition. A chest film should not be forgotten; it will help wonderfully in clearing the diagnosis.

Lesions in a right-sided sigmoid, or an anomalous position of the cecum, may cause much confusion of the clinical picture. This is easily cleared up by a colon fluoroscopy.

THE USE OF THE COLON EXAMINATION IN DIFFERENTIAL DIAGNOSIS

A colon fluoroscopy often aids in the diagnosis of lesions outside of the bowel.

Case 15. A film of the patient's genito-urinary tract showed a small dense shadow in the line of the right ureter. This shadow was unusually round for a urinary stone, and not quite uniformly dense. A colon fluoroscopy showed multiple diverticula, one of which corresponded exactly to the position of the small shadow in question. We found that stomach fluoroscopy had been done two months previously, and that a film of the abdomen, taken prior to the stomach examination, did not show the shadow in question. Evidently this shadow was due to barium retained in a small diverticulum for a period of two months.

Case 16. A patient came to the hospital with urinary bleeding and a large, nodular, slightly tender mass in the right upper quadrant. What was the mass? Fluoroscopy of the colon showed that the hepatic flexure was markedly displaced downward and forward. Firm, rather deep, pressure was needed before the barium in the colon was displaced by compression against the mass. This spoke for kidney enlargement. A compression defect of the barium is obtained by very light palpation in the case of liver

enlargement, because of its more anterior location. Bilateral pyelograms showed an irregular, bizarre filling of the right and a somewhat enlarged left, although the latter might almost be considered within the range of normal. The right pyelogram indicated a polycystic kidney, but, since the left side did not show a similar type of deformity, tumor could not be ruled out in the face of the urinary bleeding. Therefore, the patient was explored. The condition proved to be a bilateral congenital polycystic kidney, which, of course, saved the right kidney from removal.

Case 17. This patient's cystogram showed two large rounded shadows in the lower abdomen, one anterior, trabeculated, and evidently the bladder, the other posterior, smooth-margined, and larger than the bladder shadow. The differentiation between an unusually large diverticulum of the bladder and a rectovesical fistula, through which the solution had passed into the colon, was necessary. A colon fluoroscopy in conjunction with the cystogram showed the colon separate from either of the rounded shadows in question. This enormous bladder diverticulum was later removed.

Case 18. A female patient, 55 years of age, complained of severe pain in the pelvis and right leg. A hard mass was palpable on the right side of the pelvis, extending upward higher than the finger could reach, and apparently fixed to the bone. A film of the pelvis showed bone destruction in the right ischium and the inferior ramus of the pubis. A colon fluoroscopy demonstrated that this tumor (inoperable) did not arise from the large bowel. Biopsy sections showed it to be a small round-cell sarcoma. Treatment by radium and x-ray was given, the bone recalcified, and the patient is still living and well, now nine years later.

Case 19. A middle aged, very heavy woman was brought to the hospital with severe colicky pain in the right upper quad-

rant, strongly suggesting gall-bladder disease. On the plain film there was seen a large annular shadow high on the right side in the gall-bladder position, more sharply defined on the postero-anterior view. In my opinion, it was undoubtedly a gallstone. Cholecystography was not done. At operation, a small contracted gall bladder, bedded in dense adhesions, was found and removed. It contained *no stone*, and the surgeon felt no calcareous mass in this vicinity.

The shadow in question was so typical for a gallstone that I asked permission to examine the patient again. Three days after the operation, the patient, who had been doing nicely, began to have gas distention of the abdomen to such a degree that intestinal obstruction of high grade was evident. The surgeon requested a colon fluoroscopy to locate the site of obstruction, but I suggested a plain film of the abdomen first. This showed that the same annular shadow was now located in the right lower quadrant and that there was an enormous gas distention of the small bowel.

Now it was easy to reconstruct the history. After perforation by a stone the size of an English walnut, the gall bladder had contracted to the size of a man's thumb. The operative manipulation freed the stone from its bed of adhesions, which were so dense that the stone was not felt; in the three-day interval it had progressed to the terminal ileum, and was blocked by the ileocecal valve. The intestinal obstruction was relieved, and the diagnosis confirmed by the removal of the stone.

SUMMARY

With the exception of surgery, the x-ray is the only means to determine the exact position, size, and configuration of the terminal ileum, cecum, and ascending colon. With the aid of the x-ray, it is easy to say whether there is a constant filling defect, as in carcinoma, or one which is intermittent, as in spasm; whether there is a projecting

deformity, as a diverticulum, an infringement upon the lumen from a lesion within it, as from a polyp or intussusception, or a compression deformity from an extrinsic mass. These conditions may be difficult or impossible to determine clinically.

The x-ray is of great value as confirmatory evidence, and to determine the exact size and position of lesions which may be diagnosed clinically. Carcinoma and ulcerative colitis are outstanding examples.

There is also a large group of cases in which the diagnosis is inconclusive either from the roentgenologic or clinical evidence alone, but which may be correctly diagnosed by close association of both types of evidence; for example, whether spasm is due to intrinsic, extrinsic, or reflex causes; the reason for compression deformities, etc.

Close co-operation between the roentgenologist and the clinician insures the best result for the patient.

BILATERAL DIAPHRAGMATIC HERNIA¹

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THE ever increasing number of publications on diaphragmatic hernia is evidence that the condition is not so rare as has been thought heretofore. In the pre-roentgen era, a hernia of the diaphragm was seldom diagnosed as such while the patient was alive. The first two cases, which Ambroise Paré described in 1610, were found at autopsy. In 1790, two others were reported by Petit, one of eventration and one of hernia. In 1829, Curveilliers distinguished between congenital and acquired diaphragmatic hernia. The hernia may be true or false, depending upon whether or not its contents are wrapped in a peritoneal sac. Of the 635 cases gathered by Eppinger, in 1911, from the entire literature, only a few were diagnosed during the life of the patient. Gradually the roentgen examination took first place in the diagnosis. In 1924, Moore and Kirklin estimated the number of described cases at 1,200. Up to this time only 20 cases had been diagnosed at the Mayo Clinic, a number which, six years later, had increased to 110. Similar reports are made by Healy, Morrison, Akerlund, Hedblom, LeWald, and many others.

While Quenu, in 1921, considered the hernia at the hiatus esophagi as extremely rare, Moore and Kirklin, Akerlund, Morrison, Ritvo and others found this to be the most common type. Other sites at which a hernia may occur are the trigonum costosternal (foramen Morgagni), the trigonum costolumbale (foramen Bockdalecki), the foramen quadrilaterum, and the foramen nervi sympatici. It is more common on the left than on the right side. Of the 635 cases reported by Eppinger, only nine were on the right side. It appears that the large bloc of the liver prevents the formation of a hernia. However, Reich, in three of his cases, has shown that parts of the liver may form the contents of a diaphragmatic hernia. More frequently, the sac of a hernia contains stomach, intestines, omentum, or a combination of these. The sac may be small and may, in certain positions of the patient, reduce itself automatically. It may be found only by placing the patient in certain positions. However, it may reach large dimensions and fill the entire side of the chest.

The parasternal type of congenital diaphragmatic hernia is very rare. Woolsey found one case of hernia of the left, and Siehlmann one case of the right, foramen

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.



Fig. 1. The upper margins of the hernias, which are separated by the mediastinum, are marked by arrows. To the right of the heart, as well as to the left, traces of barium and gas in the bowels may be seen. Notice the gas bubble in the cardiac portion of the stomach. The diaphragm is distinct on both sides.

Morgagni. Hedblom gathered six cases. All these, as well as all cases of diaphragmatic hernia heretofore described, have been unilateral. There is no case of bilateral hernia of the diaphragm previously described in the literature.

CASE REPORT

Miss McG—, aged 60 years, a business woman. Since the onset of her periods, the patient had suffered from dysmenorrhea. Up to 1912, she had never been sick or had any injury or accident, but in that year she was operated on for a huge uterine fibroid, which weighed 28 pounds. Before, and after this, she passed three examinations for life insurance. After the operation, she began to complain of continuous gas pains and of occasional severe attacks of cramps in the abdomen and chest, whenever the bowels became only slightly constipated, and a gradually increasing shortness of breath, with a sense of exhaustion after the least exercise. Bending forward was an especially great ef-

fort for her. By keeping the bowels in good condition and avoiding exercise, she managed to keep comfortable and to pursue her vocation. One of her occasional attacks brought her to her physician, who sent her to St. Mary's Hospital to be roentgenographed.

Examination revealed a well nourished patient, white, weight 175 pounds, blood pressure 162/98. There was no cyanosis. The chest expansion was from 40.5 to 41.5 inches. There was a slight venous marking in the region of the sternum. At the third rib anteriorly on the left side, the normal sounds of the lung changed to flatness. The same condition was found on the right side, beginning 0.5 inch lower. Posteriorly, the normal sounds extended to the eleventh rib on the left side and to the tenth rib on the right. Auscultation revealed normal breathing on both sides down to the fourth rib anteriorly, and over the entire lung fields posteriorly. Sounds of regurgitation could be heard over the areas of flatness, especially when the patient changed her position. The heart sounds were normal. The heart borders could not be outlined, nor the apex beat felt. The abdomen was soft and not distended. A scar extended from the navel to the symphysis. The liver was soft; its edge, which was felt about one inch below the costal margin, moved readily with respiration. There was pronounced tenderness in the entire epigastric region.

Under the fluoroscope the upper lung fields appeared clear. From the third rib down, a shadow which occupied the anterior part of the chest and included the heart, was superimposed upon both lung shadows. Its upper margin, which was very distinct, moved slightly with respiration. Posteriorly it was easily distinguished from the lung tissue on both sides. Within the shadow, which was otherwise uniform in character, on both sides one saw the shadows of gas bubbles, as well as those of the barium particles from the meal which the patient had had



Fig. 2. After passing through a normal esophagus, the barium fills the stomach by travelling from the cardia toward the sternum underneath the diaphragm. It then turns upward into the chest cavity and goes straight downward and medially toward the pylorus. The latter is in a normal position, and forces the barium to make again a turn upward to enter the duodenum.

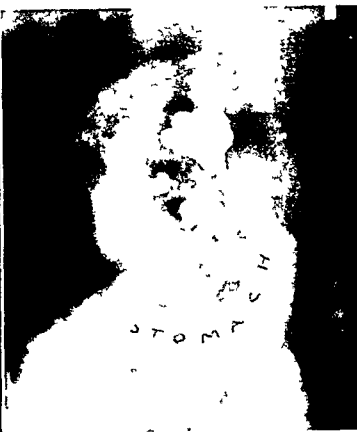


Fig. 3. In this lateral view, both infra- and supra-diaphragmatic portions of the stomach can be clearly seen, together with both loops of the colon. The total extension of both hernias is marked by a large shadow which wraps around both colon and stomach.



Fig. 4. The stomach filled, showing infra- and supra-diaphragmatic portions. Both left and right loops of the colon in the chest are also visible.

six hours before. The diaphragm could be clearly distinguished, being lower on the left side than on the right. The posterior part of the diaphragm, being next to lung tissue, was clearest. It moved with respiration. With the patient in the Trendelenburg position, the size of the mass did not change, nor was there any considerable change seen with the Mueller or Valsalva tests.

A barium meal given to the patient (Figs. 1, 2, 3, and 4) revealed a normal esophagus. The cardia contained a gas bubble. The barium appeared to remain there for a short time, but, when the patient was placed in a lateral position, one saw the barium travel forward and medially along the lower surface of the diaphragm until it reached the anterior chest wall. There it made a sharp turn upward, penetrating through an aperture in the left sternocostal attachment of the diaphragm into the chest cavity on the left side. It remained in this location for a considerable length of time. Finally small portions traveled in a straight line down-

ward and medially to a point which corresponded to the position of the pylorus, to the right of the median line. To pass through the pylorus, it made another sharp turn upward, entering the apparently normal duodenal cap, and passing through the duodenum into the jejunum. The bulk of the barium remained in the cardiac and supra-diaphragmatic portions of the stomach, giving the impression of a dumb-bell.

After six hours, the small intestines were in normal position, the stomach was empty, and the head of the barium column had reached the middle of the transverse colon. The ascending colon rose straight upward and medially to an aperture in the right sternocostal attachment of the diaphragm, at which point it was bent like a water hose over a sharp edge. In the right chest, it formed a loop, returned to the aperture in the diaphragm, turned again 360° around the sternal attachment of the diaphragm into the left chest, formed a loop around the stomach, and then re-entered the abdominal cavity, to continue into the pelvis in a normal manner as the descending colon. The barium enema flowed freely and without

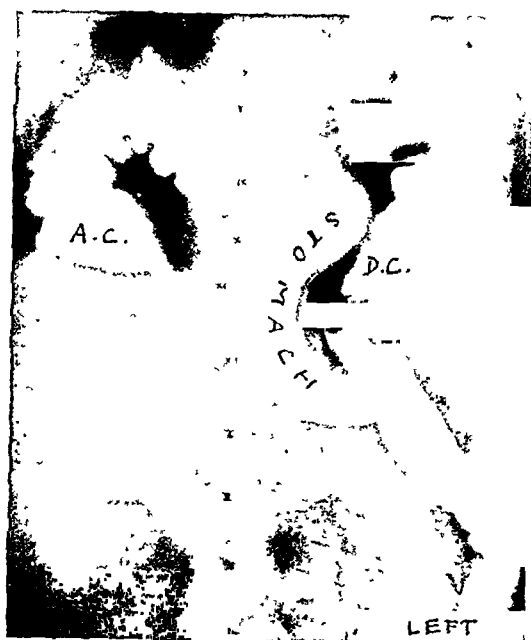


Fig 5. Anteroposterior view after a barium enema, with the barium meal in the stomach. The loops of the ascending and descending colon correspond to the holes in the diaphragm at the level of the eleventh dorsal vertebra. The loop in the transverse colon has pushed the sternal portion of the diaphragm upward to a point opposite the upper margin of the tenth dorsal vertebra.

stopping at any of the three sharp turns through the hernial rings. The impression was that all the organs were fixed in position in the apertures of the diaphragm. Neither the Mueller nor Valsalva tests in the upright, horizontal, or Trendelenburg positions was able to produce a change in position of the stomach or colon (Figs. 5, 6, 7, and 8).

As the colon and stomach did not entirely fill out the supradiaphragmatic shadows, it was concluded that the omentum was also a part of the contents in the hernial sacs. The sternal portion of the diaphragm was apparently a narrow strip of muscle, which, due to the increased abdominal pressure on the transverse colon, had been pulled somewhat upward. There was no evidence that the liver or the small intestines had penetrated into the chest. The heart always lies posterior to the two loops of the colon. It

had not moved to either side, but appeared to be pushed back slightly. After evacuation of the enema, only a small residue of barium was distributed throughout the colon.

COMMENT

The patient did not give any history of an accident, which led to the conclusion that the hernia was a congenital defect. After the removal of the huge fibroid tumor, the previously well balanced arrangement suffered the loss of its support. The ascending and descending colon started to pull downward, and thus produced a sharper turn around the rings in the diaphragm, with symptoms of stricture whenever the patient inclined toward constipation. The symptoms of shortness of breath are easily explained by the fact that the colon interfered with the closely adjacent heart. Healy's syndrome of substernal pain, regurgitation when in the supine position, dyspnea, and vague stomach distress is also present in this case. Contrary to Healy's findings, this patient had considerable pain in the epigastrium. There were no complaints of vomiting or hyperacidity. A gas bubble in the cardiac portion of the stomach was always present, which is contrary to LeWald's experience, who found it absent in cases of diaphragmatic hernia with involvement of the stomach. This is explained by the long course the barium took under the diaphragm, contrary to that in hernia of the esophageal hiatus or other posterior hernias, in which the stomach turns directly upward.

It was most interesting to observe the excursions of the diaphragm and of the upper margins of the hernias. With normal respiration, the hernias showed almost no excursion, and the posterior half of the diaphragm moved slowly and equally up and down. Most of the breathing was done with the muscles of the thorax. With inspiration, the shadow of the hernias seemed to grow larger, as the receding diaphragm allowed

the basic part of the hernias to be exposed. This phenomenon, which became more prominent with deeper inspiration, could best be seen when using the Mueller test on the patient. This test consists of a forced inspiration, which is suddenly stopped by letting the patient close the glottis while he is still trying to inhale. The diaphragm will descend to an extreme position, and the hernia, through the flattening out of the diaphragm, as well as through the increased negative pressure in the chest, will appear larger. Besides, the increased negative pressure may aspirate an additional amount of contents from the abdomen. By this method one successfully can demonstrate hernias which under ordinary circumstances would escape the eye of the examiner, due to being too small or to having been spontaneously reduced in the position observed.

The Trendelenburg position, in which the patient is to be placed in order to increase the pressure of the abdominal organs upon the diaphragm, is indispensable in the examination for diaphragmatic hernia, with and without the Mueller and Valsalva tests. The Valsalva test is not so useful as the Mueller test, but it aids considerably in making a differential diagnosis. After a deep inspiration the patient closes the glottis and tries to make a forced expiration, resulting in an upward motion of the diaphragm. If there is an abdominal type of breathing, as in males, the increased abdominal pressure, which may be higher than that of the thorax, may drive abdominal organs or parts of them through the locus minoris resistentiae of the diaphragm into the sac of the hernia. But, if the pressure of the thorax plus that of the diaphragm is higher than the abdominal pressure, as in the thoracic breathing of females, the hernia may be reduced or may disappear entirely, unless adhesions hold it in position. Both tests may be employed with success for differential diagnosis of hernia and pleuritic adhesions, encapsulated pleuritic exudates, and so on.

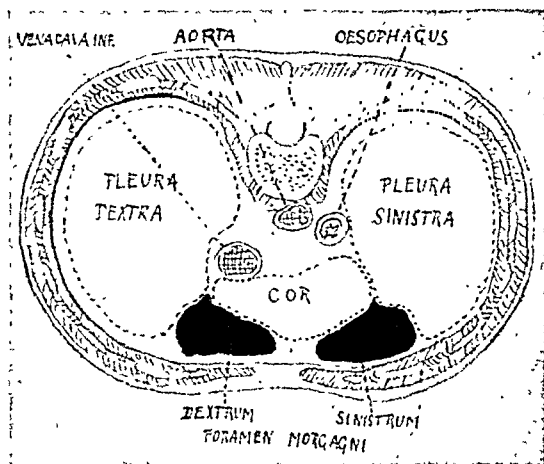


Fig. 6. Cross-section through the diaphragm showing the hernial rings in the left and right foramina Morgagni.

In cases of unilateral hernia, there is a paradoxical upward motion of the diaphragm, as well as of the sac, at the beginning of the inspiration. The motion of the hernia is imaginary only insofar as the diaphragm recedes and allows one to visualize more of the base of the sac. Before entering upon the downward motion, the diseased side will go up and, with it, the hernia. The reason for this is that the function of the perforated side is not so good as that of the normal side. The excursions of the normal side, therefore, are greater. With beginning inspiration, the pressure of the normal side and of the abdomen will be transferred to the weaker side. It will push the latter upward until it has gained strength enough to overcome this pressure and to join with the normal side in its downward motion. Naturally, this phenomenon is more evident in the abdominal type of breathing, and, for this reason, the sex of the patient, in some cases, governs the findings.

In our case, the above mentioned tests could not be demonstrated as clearly as in others, as the hernia was bilateral. The tests brought out very clearly that the sacs of the two hernias were fixed in position, together with their contents. Neither the



Fig. 7. Right oblique view, showing the extent of both hernias. The posterior portion of the diaphragm is intact.



Fig. 8. Left oblique view. The shadow of the left hernia may be seen separated from that on the right. The sacs contain parts of other abdominal organs, as well as the colon.

upright, horizontal, nor Trendelenburg positions changed their size or shape.

TREATMENT

Though the possibility of intestinal obstruction is present, it is rather small, considering the patient has always had this condition. She refuses any kind of surgery, so that a pneumoperitoneum has not been undertaken. Therefore, the treatment should consist of general medication to prevent constipation. The meals should be small and frequent, nor should the patient take strenuous exercises. If she follows these few rules, there is no reason to believe that the condition should shorten her life or cause greater distress.

SUMMARY

1. Diaphragmatic hernia is more frequent than is generally believed.
2. A case of bilateral diaphragmatic hernia through the left and right foramina

Morgagni is reported. This the author believes to be the only case on record.

3. In addition to the Trendelenburg position, the Mueller and Valsalva tests are recommended as valuable aids to the diagnosis of diaphragmatic hernia.

4. A short review of the literature is offered.

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DISCUSSION.

DR. G. E. PRAHLER (Philadelphia, Pa.): These cases, which must be very rare, are of more than mere inquisitive interest. Review of them will often help us, if we should have such cases presented to us, to avoid making some serious mistake. A patient suffering from this lesion may have either serious abdominal or thoracic symptoms. It would be very easy with a hasty or careless examination, either physical or roentgenographic, to make a wrong diagnosis and get into grave difficulties. Therefore, when a case such as this is brought to our attention, it makes us all a little bit more alert.

I will illustrate what I have in mind. About ten days or two weeks ago, a patient was sent to Dr. Gabriel Tucker at the Graduate Hospital, in Philadelphia, for the removal of a foreign body in the lung. A roentgen-ray examination had been made, and the patient had been studied elsewhere, but Dr. Tucker is especially particular about having roentgenographic examinations carefully made before he will undertake a bronchoscopy.

When we studied this patient, instead of finding a foreign body in the left lung—which was diagnosed, and which Dr. Tucker was expected to remove—we found a total absence of the left side of the diaphragm, with the large and small intestines filling most of the left lung area. The stomach was down in the abdomen. The patient had thoracic symptoms. This 12-year-old child had gone these 12 years without having any serious symptoms.

It is remarkable how many patients with these congenital defects, exemplified by the case reported by Dr. May, as well as those reported by others, go through a long life, sometimes reaching old age, before anybody even suspects this very serious defect. Most of us think we could not live with this lesion. In general, I think that, when we find these conditions, we must not interfere too much with Nature's method of dealing with our problems. When we do, we will perhaps add to the difficulties rather than lessen them.

DR. MAY (closing): Diaphragmatic hernia is not so rare as we have all thought it was. It creates symptoms which might represent almost anything. To find a small diaphragmatic hernia might solve much trouble for which the patient comes to his physician. It may possibly be operated upon, and the patient cured; but it is difficult sometimes to find the hernia unless we look for it. Just as we look for gastric ulcer, or for any other abdominal or chest condition, we should always, with every gastro-intestinal and chest examination, think of the possibility of diaphragmatic hernia.

THE SIGNIFICANCE OF THE RADIOLOGIC FINDINGS IN LOW BACK PAIN

A REVIEW OF 500 CASES

By WALLACE DUNCAN, M.D., Cleveland Clinic, CLEVELAND, OHIO

AT first glance it might appear to be sheer presumption for one primarily interested in orthopedic surgery to attempt an evaluation of the radiologic findings in a group of patients complaining of low back pain, but it is quite evident that the merit and the significance of this procedure are determined by the clinical application of the facts elicited by roentgenographic examination.

When one considers that the radiologist at one time or another reviews the roentgen plates of virtually every one of these patients during the course of his or her disability, it would seem perfectly logical to present before this organization the findings elicited in the review of a rather large group of cases. The records of 500 consecutive patients presenting themselves in the department of orthopedic surgery with the predominating complaint of distress of one or another type in the lower back have been reviewed. No attempt has been made to approach the situation with preconceived ideas about the findings anticipated, other than those that are bound to be impressed upon one as the result of repeated clinical observations.

Doubtless every radiologist on many occasions is asked by the clinician for his opinion as to whether or not what is seen is sufficient to produce symptoms varying greatly in degree and character in different individuals. Consequently one feels justified in mentioning certain phases of the problem of low back pain which bear out certain fundamental beliefs. Can anyone with any degree of certainty or justification voice any opinion upon the status of any case from the mere radiologic aspect, except in certain patients manifesting definite de-

structive lesions? Is the clinician always within the realm of certainty when he feels that the hypertrophic changes in the lumbar spine or the sacralization of the fifth lumbar transverse process are the agents productive of a patient's backache? No more striking demonstration of the futility of haphazard investigation and opinion can be found than in the woman, aged 35, whose lumbar spine on roentgenologic examination reveals nothing pathologic and yet who is markedly incapacitated for her household duties. Likewise the radiologic findings are of little clinical significance in the case of the man of 65 who presents himself because of urinary difficulties, whereupon examination of the genito-urinary tract reveals hypertrophic changes of marked degree in the lumbar spine, yet the patient has never known the meaning of backache or lumbago.

The statement to follow may be at absolute variance with the opinion of many, but nevertheless it is the outgrowth of the careful clinical investigation of a large number of such persons in every walk of life. Unquestionably first in order of importance stands the accurate recording of facts from the inception of the patient's complaint. Secondly, and of almost equal importance, is the general physical examination to include comprehensive investigation of possible foci of infection and the analysis of body habitus. The relegation of roentgenographic examination to a minor position is in no way intended to minimize the importance of and the necessity for x-ray investigation, but rather to stress those features of the problem which are so frequently thrown into the discard and overshadowed because of a radiographic report revealing a departure from normal which may have no bearing

whatever upon the symptoms. The necessity for radiologic study is manifested by the fact that each of these patients and all others with similar disability are routinely examined in the radiologic department; yet if the history and physical examination were relegated to second place, there would be no criteria for judgment in the large group of patients suffering from low back pain, in whose x-ray plates no evidence of pathologic change is found. It is obvious that the purely clinical aspect of the situation can not be ignored and if the study of these patients is carried out in an intelligent and comprehensive manner, the basis of their symptoms can be determined as accurately, if not with even greater certainty, than in the majority of intra-abdominal and intrathoracic abnormalities. The significance of all findings can be determined, just as in the solution of the problem of the chronic arthritic patient, only by the co-operation and the collaboration of the radiologist, the nose and throat specialist, the dentist, the gynecologist, the genito-urinary surgeon, the neurologist, and the orthopedist.

In this discussion I can not deal in detail with the therapeutic phases of the situation, but here again it has been demonstrated that haphazard methods of approach both on the part of the physician and the patient are productive of disappointment and the discrediting in the minds of both of therapeutic measures basically sound, if properly applied. The results obtained do not depend more upon the accuracy of diagnosis or upon the conscientiousness with which the treatment is pressed than upon the co-operation of the patient in adopting the treatment indicated. End-results depend upon the status of the patient, his economic limitations, his intelligence, and his industry.

As to the types of disability presented in this analysis, I shall refer, first, to that person so frequently encountered and best exemplified by the younger woman, possibly of asthenic type, who may or may not have

had backache since adolescence. She commonly develops an ache in the lower back on getting about after delivery of a child. This patient gets up in the morning feeling absolutely free from her discomfort. She never has any stiffness in the lower back on bending over or on turning in bed. As the day wears on, her backache develops and to secure relief she may be forced to sit down, or even to lie down, with her hand or a pillow placed beneath the small of the back. She has become wedded to a corset because her "back would break" if she did not wear it. During her menstrual period her symptoms are much worse. This is the classical history of the patient, who, on examination, shows a more marked hollowing of the lower back than normal, free movement in all directions, with the production of her typical discomfort on hyperextension of the spine, and tenderness on pressure over the lumbosacral joints and the lower lumbar spinous processes. This patient has had posture—a mechanically defective back—a genuine disability, in many cases highly incapacitating.

In the group of 500 cases, about 170 cases, or 34 per cent, fall primarily into this category. Of these, 78 per cent were females, and an anomaly of the lumbosacral region was recognized once in every 15 cases. In two-thirds of these patients the roentgenograms were reported as negative, while the other third showed some variance from normal, either a sacralization of the fifth or sixth lumbar transverse process, mild arthritic changes, or a slight scoliosis to one or the other side. These plates were all taken in the recumbent position. With this evidence, there is no contra-indication to the institution of physical therapeutic measures. In this group, the confirmatory rôle of the roentgenogram in ruling out destructive lesions, in determining whether or not contra-indications to certain forms of therapy exist, is doubtless the greatest indication for further radiologic investigation.

The question might be raised as to whether any benefit accrues from the substantiation contributed by the roentgenographic findings. In no case in this group did the x-ray findings materially influence the therapy instituted, but they substantiated the *rationalc* of the treatment. Lateral plates, particularly of the lumbosacral region, taken in the erect position, contributed even more to the accurate analysis of the clinical picture. It is in this type of patient that nothing supplants the regimen of adequate rest, the avoidance of fatigue, the elimination of focal infection, the adoption of a sane dietetic routine, the application of heat locally, massage, instruction in muscle re-education, with the correction of mechanical defects, and, in a fairly high proportion of cases, the adoption of a brace or corset. Pelvic inflammatory disease has been found to be a rare cause of this type of disability: Focal infection was present in 73 per cent of these patients and prostatic infection was looked upon as a factor in 11 of the male patients; syphilis was present in 5 cases.

Every one is familiar with the group of patients typified by the short, thick-set man who has done heavy work and who from his early thirties may have been subject to recurrent attacks of lumbago, with periods of perfect freedom between attacks. As time goes on, he commences to have stiffness on bending over in the morning, with the disappearance of discomfort on so-called "limbering up." Toward the end of the day, on arising from a chair, discomfort and stiffness are again in evidence. Some mechanical defect may be shown on physical examination, but, more often, there is definite limitation of movement, with virtually no localized tenderness on pressure over the lower back. Heberden's nodes may be present, and crepitation in the knees frequently may be felt. A smaller group of elderly persons, particularly women, may present all the characteristics of an atrophic process, and in others may be found the

rigid spine of the ankylosing type of arthritis. It is in this group that infection and metabolic disturbances probably play their greatest rôle, and doubtless many of the patients in the group under investigation in whom no lesion is shown radiologically may not have reached the stage of gross change manifested in the lumbar spine. Into this category have fallen 230 patients, of whom 160, or approximately 70 per cent, were males. Among these, focal infection was demonstrated in all but 30 cases and 56 were suffering from chronic prostatitis. There were 3 patients with syphilis.

In this group, 61 patients (virtually all males) presented definite evidence clinically of acute infectious arthritis of the sacroiliac joint. There is little or no radiologic evidence to support this diagnosis, and in this group of cases little assistance, as a rule, is obtained from roentgenographic study. In those with an infectious basis, one concludes that tonsillar, prostatic, and dental infection play highly important parts, since one or more foci were readily demonstrated, almost without exception. This infectious condition is always made worse by manipulation.

In 158 of these 230 cases there were changes demonstrated radiologically which would have been anticipated from the clinical examination. It is obvious that many of these patients had an early arthritic process without any radiologic evidence of it. In this group, there is a distinct discrepancy between the clinical impression and the radiologic findings in many instances. In the 72 cases in which the roentgenographic findings were reported as normal, it is apparent that, without adequate data obtained from the history and physical examination, the difficulty of the therapeutic problem becomes much greater. In this group, the presence of radiologic changes greatly facilitates the solution of the problem, but the absence of gross change does not demonstrate that the

disease is not present in any one of these patients with arthritic symptoms.

One of the most difficult phases of this problem is the differentiation between lumbosacral and sacro-iliac lesions. A tumor of the lower cord may be confused with this type of disability. The patient with a history of "something snapping" in the lower back during heavy lifting, or the patient with the gradual onset of pain in either sacro-iliac region, with pain referred down the posterior surface of the thigh and the outer side of the calf to the ankle, presents the classical complaint of a sacro-iliac lesion. These symptoms are always aggravated by activity and relieved by rest. Marked pain on straight leg raising, with discomfort referred to the affected sacro-iliac joint, and pain slighter in degree in the same joint on straight leg raising on the opposite side, are common accompaniments of this symptom-complex. Frequently the differential diagnosis has to be made between a sacro-iliac lesion and a tumor of the spinal cord because of typical pain on coughing, sneezing, and straining at stool. These particular symptoms are by no means pathognomonic of cord lesion, as some orthopedists believe.

In cases due to injury, manipulation, applied promptly and adequately, results in improvement. Fractures of the lumbar spine accounted for 18 cases of disability in the lower back. About forty patients in this series fell into the group with trauma to the sacro-iliac region. In this group fractures were readily demonstrated in a lateral film and on clinical examination presented little difficulty in diagnosis, since a history of trauma in such instances was recorded.

Thirty-seven cases were encountered in this series in which destruction of a malignant or tuberculous character was manifested. There seems to be a definite disparity in this column, as compared with the statistics of other workers, and a proportion as low as this might not be encountered in another series of cases studied over a period

of many years. Of these 37 patients, 17 had Pott's disease. In most of the cases of malignancy, the changes in the spine were obviously metastatic. In these cases, severe back pain, especially at night, in the presence of primary malignancy is highly suggestive of spinal metastases despite negative roentgenograms. Among those exhibiting changes resulting from malignancy, it was proven that two were suffering from multiple myelomas. In the earlier months of observation it was felt that their low back symptoms were the result of some hypertrophic process. In one patient the peculiar phenomenon of coagulation of the blood serum on heating to 55° C. was later shown to be due to the presence of Bence-Jones protein.

No case of Charcot spine was encountered in this group of 500 cases.

In this series of cases, only 5 patients were thought, from a clinical point of view, to have no mechanical, arthritic, infectious or malignant basis for their complaint. There was one case of spinal cord tumor, one of carcinoma of the sigmoid, one in which symptoms apparently arose from a thrombosed internal hemorrhoid, and in two cases the symptoms obviously arose from prostatic disease. No abnormality was shown radiologically in any one of these cases.

It would be purposeless to present illustrations of the conditions discussed, since there is relative unanimity and uniformity of opinion regarding the variations from normal that have been reported.

The most disappointing phase of such a review is the failure to have the opportunity of following these patients over a long period of years. In each case, however, there was sufficient observation to make fairly certain the category in which each case belongs.

In reviewing this group of cases, I feel more than ever that an attempt to prove from roentgenograms alone whether disabili-

ity does or does not exist is an extremely pernicious practice. It is obviously unfair, if it is based upon impressions which have no clinical substantiation, and frequently prejudices the status of a patient who has a perfectly justifiable claim to disability. As an example may be cited the patient with a minimal amount of hypertrophic change who sustains injury to this area, with a subsequent prolonged period of incapacitation. Although a certain proportion may adopt malingering as a means to an end, there still remains a large number of patients with genuine disability, the degree of which can be determined only by adequate clinical observation and analysis. It is equally reprehensible to read into radiographic reports the findings of the problem at hand, when it is certain that if proper discrimination were used it would be proved that the alleged con-

dition could not be present. Injury, either single, severe, repeated, or apparently negligible, and also focal infection might produce in any one of the 500 patients a train of symptoms on the one hand relatively insignificant or highly incapacitating on the other. Intelligent roentgenographic examination and interpretation is essential, and comprehensive clinical investigation is imperative if an accurate analysis is to be made and if rational therapy is to be instituted.

In conclusion, there exists a sufficiently large element of error in the diagnosis of low back pain, regardless of the thoroughness and comprehensiveness of the clinical investigation, to make roentgenographic examination of the area obligatory in order that there may be some degree of certainty as to the fundamental factors involved in the production of the disability.

THE QUALITY DETERMINATION OF THE ROENTGEN RAYS¹

THE HALF VALUE LAYER AS A PRACTICAL METHOD OF ESTIMATING THE QUALITY OF ROENTGEN RAYS

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THE need of establishing some universally satisfactory and comprehensible method of quality designation of roentgen rays still exists. Though extreme accuracy may not be attainable, nevertheless some method should be adopted which is easily comprehensible and sufficiently simple of execution to be practically applicable by the average medical roentgenologist. The method should not only avoid complexities of procedure, but should be sufficiently simple of quotation as to be readily communicable. My effort, therefore, will in the main be an attempt to determine, by ex-

clusion, the most satisfactory of the present-day methods.

In selecting a standard for quality measurement, it should be remembered that the problem is not limited to high voltage therapy only, but that a vast number of machines are being operated at medium low voltages, with little or no filtration, especially in superficial therapy, and that qualitative standardization is also required in radiography. Any qualitative method of determination that does not encompass the whole field is not worthy of consideration.

Before proceeding with the problem at hand, a question arises which entails a definite moral obligation, namely. Is it right

¹Read before the Radiological Society of North America, at the Eighteenth Annual Meeting, at Atlantic City, Nov. 28-Dec. 1, 1932.

to request and accept for therapeutic purposes qualitative and quantitative calibrations from manufacturers' representatives and lay technicians? In radiography, perhaps the worst that can happen is a poor quality film. For therapeutic purposes, physical measurements by lay individuals may be justifiable; however, whence the authority to designate any given biologic reaction, skin or depth dose? Any statement at the bottom of a calibration chart absolving responsibility for quotations is a subterfuge, an admission of lack of authority. The responsibility for qualitative and quantitative dosage, as applied to the human being, still remains definitely medical.

Whether for diagnostic or therapeutic purposes, all of us must have experienced the uncertainties and vagaries of voltmeters, point, and sphere gap methods of quality estimation on different installations. Though each of us can, with reasonable safety, employ the arbitrary subdivisions of a given voltmeter for technical reduplication on the same installation, how many of us have attempted to transfer a given technic from one installation to another, using given meter readings, and have found that, both in roentgenography and therapy, a totally different type of radiation was forthcoming? If additional illustrative examples are required, we mention several machines recently tested,² all operating under the same sphere gap measurement control. On these, the kilovolt readings varied from 64 to 90—not one of the meters corresponded to the 76 K.V. indicated on the sphere gap scale.

As a further indication of the vacillation in x-ray quality on different installations with voltmeter control, the half value readings furnished some interesting facts. Of the several machines tested, each operated with the same voltage meter reading, only two, machines of the same model, showed any approach to uniformity in quality. In

the others, over 100 per cent variation in x-ray quality was discernible. Transferred to a comparative peak voltage scale, the variations in the half value measurements of the different machines represent a range of from 65 to 110 peak kilovolts. This vacillation would result in severe under- or over-exposure of diagnostic films, or be of serious consequence in therapy.

VOLTAGE QUOTATIONS

Chart 1 shows the approximate voltages in relation to the measured x-ray quality. On the first line, wave lengths in Ångströms are indicated. It is important to remember that these quotations indicate the minimum wave length. Though spectrographic measurements afford a quite accurate means of determining voltage, nevertheless this method of quality measurement fails to indicate the ray quality when strongly filtered radiation is employed. That is, notwithstanding the definite change in the ray bundle produced by filtration, nevertheless the minimum wave length measurements remain practically the same.

The comparative voltage quotations on Chart 1 are quite futile unless strict attention is given to the footnotes. Each of the calibrations will suffer considerable variation, depending not alone upon the type of measuring instrument employed, but varying further with differences in types of currents, methods of rectification, size of condensers, resistances, altitude, etc.

Even discounting the personal element of vacillation, such wide variations in spark gap and kilovolt quotations can be met as are illustrated in Table I, yet with the half value quality measure the same throughout.

VOLTAGE AS A MEASURE OF QUALITY

In Table I, the variations in centimeter sparking distance, with spheres of different size, should be noted (Experiments 2, 3, and 4), also the differences in voltages with

²In conserving expense, three illustrations which can be found in publications referred to are not included here.

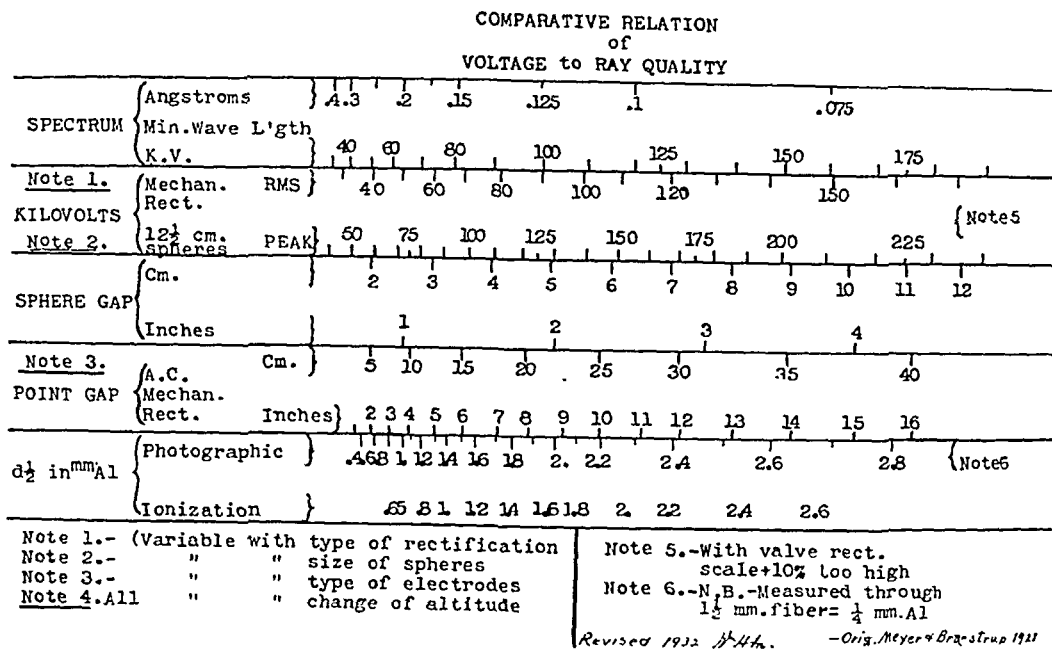


Chart 1. The footnotes on this chart are of major importance in illustrating the uncertainty of most of the present-day voltage quotations.

TABLE I.—VARIATIONS IN SPARKING DISTANCE AND K.V.P. READINGS WITH DIFFERENT MACHINES UNDER DIFFERENT MEASURING CONDITIONS. THE QUALITY OF THE RAY BUNDLE REMAINS PRACTICALLY THE SAME.*

Experiment	Type of instrument	Type of current	Spark distance	Relative kilovolts
1.	Spectrum	Constant potential		150
2.	25 cm. spheres	A.C. 4 valve rectifier	+ 6.7 cm.	(peak) — 180 (R.M.S. 130)
3.	10 cm. spheres	A.C. 4 valve rectifier	— 9 cm.	(peak) 180
4.	12.5 cm. spheres	A.C. 4 valve rectifier	— 7.8 cm.	(peak) 180
5.	12.5 cm. spheres	A.C. mechanical rectifier	+ 9.6 cm.	(peak) 200
6.	Blunt points	A.C. mechanical rectifier	+ 36—cm.	(peak) 200

*In all the above, the half value layer was at +11 mm. Al, using 0.5 mm. Cu as filter.

spheres of the same size but with change in the type of current (Experiments 4 and 5). With other types of electrodes, wide variations between the minimum and maximum sparking distances, as indicated in Experiments 5 and 6, will be observed.

In a former article (2) variations (approximating 160 per cent) in intensity output of different installations were reported. These all operated under presumably the

same voltages. In another communication (3) variation of over 350 per cent between different types of installation was recorded. If to this is added the difficulty encountered in accurately measuring the high capacity, valve tube rectified equipment, especially of the recent condenser type (whether in roentgenography or therapy), the futility of the spark gap method of calibration for quality determination becomes apparent.

COMPARISON OF METHODS
FOR QUALITY DETERMINATION
OF HETEROGENEOUS RADIATION

Half Value Layer	mm. Al	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(A)
Layer	mm. Cu		.1	→	.2	.3	.4	.5	.6	.8	1.0	1.2				(B)
Per cent Transmitted	mm. Cu through	10	→ 20	30	40	50	60	70	80	90	100					(C)
Absorb. thru mm. Al	mm. Cu	→ 20	30	40	50	60	70	80	90	100						(D)
Equal to	mm. Cu	17	12	11	10	9	8	7	6	5	4	3	2	1	0	(E)
Effect Wave Length	Angstrom Unit		.41	.36	.32	.28	← .24 →	.21	.18	.16	.15	.14	.13	.12	.11	(F)
					.3	.27	.24	.21	.19	.17						(G)
<p>Line G * Transcribed from Method (D) " G " " " " " (F) " H " " " " " (C) or (absorption through copper) → Arrows indicate limitation and direction of practical application of method <small>Measurements by Desbaur Electroscopie revised 1922 J.M.M. AC Mechn Rect and Coolidge tube used Original Meyer and Brdestrup</small></p>																

Chart 2. From the several methods of quality determination here charted, the greater numerical subdivisions and wider useful extent of the scale of the half value layer in aluminium should be apparent.

Added to this is the absolute uselessness of estimating ray quality by voltage or any other method than by measuring the ray bundle, when filtration of any kind is employed.

A little experimentation and thought on the matter will force one to the conclusion that the greatest vacillation in intensity output is ascribable to voltage variations. This becomes more apparent when one considers the fact that "intensity varies roughly as the square of the R.M.S. voltage." Experience has taught us that, once a given set of operating conditions has been thoroughly tested, then it is fairly safe to presume, under these fixed operating conditions, that sufficiently constant qualitative and quantitative output will, for a reasonable period, be maintained. Of course, the proviso maintains that no changes of any kind have been made in the installation. This refers to the milliamperage, voltage, time, and distance control, as may be expressed in the formula $\frac{AXV^2XT}{D^2} = I$ (4). Nevertheless, as the tube ages, or with the slightest provo-

cation or change in operation, an immediate re-check is essential.³

From what has been said, it must be more than apparent that, whereas meter control on a fixed installation, properly standardized, is justifiable, for purposes of communication or reduplication (at the present time), the transfer of voltage quotations from one equipment to another is absolutely worthless as a check on quality.

It is most desirable that a uniform standard of voltage recording be established. However, the problem of quality determination (with filtered radiation) still remains and will be solved only by direct measurements of the emitted radiation.

THE MORE IMPORTANT METHODS OF QUALITY MEASUREMENT⁴

The adoption of a single method for determining and expressing the quality of the roentgen rays appears to us to be just as

³A routine check at least once a week would not be considered by us to be superfluous.

⁴Because the line of reasoning holds its continuity, the author re-quotes in part, with minor revision, from a former publication (5).

important as the acceptance of a standard unit of intensity measurement.

Our former work consisted of the comparison of several proposed methods for

measurements below 0.1 mm., as is required in Method B (Chart 1).

Thus, for fractional determination of even the half value layer in copper, and for

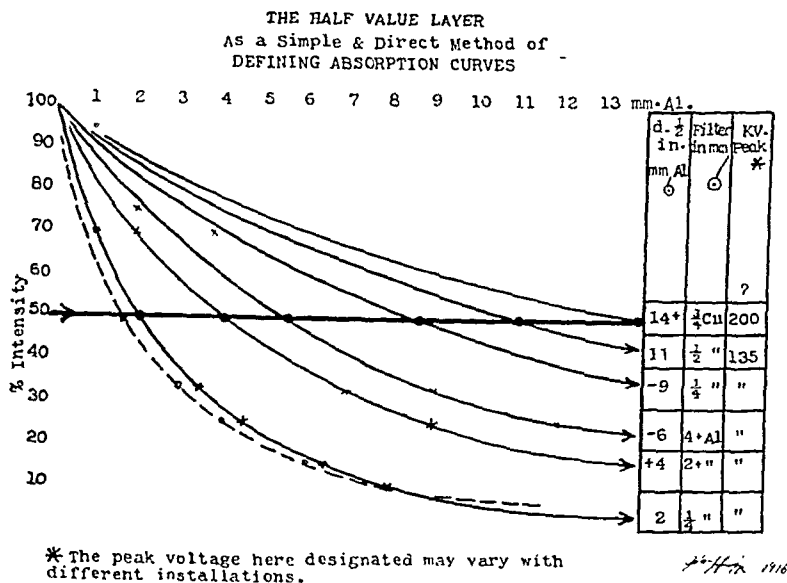


Chart 3. Though this chart is purely illustrative, the curve projections will be found reasonably correct, since they are a composite of both photographic and ionometric measurements. The relation of the two procedures is indicated in the first two curves; the broken line (measurement by ionization) as compared with the continuous line (photographic measurement) of the same ray quality. That these two lines probably cross one another at shorter wave lengths is indicated at the right-hand end of the curves.

The tangents drawn indicate the main components of the otherwise complex heterogeneous beam. Curves similar to these can be drawn in which copper is substituted for the aluminum as an absorbing medium. There is no doubt but that variations in absorption curves, as here designated, may occur with different voltages and filtration, wherein the same half value layer might be obtained. Notwithstanding these slight variations, by no stretch of the imagination could any difference in biologic reaction be discernible if the intensity in the depth, as indicated by the half value layer, remains the same.

Surely it is evident that the quotation of the half value layer is the simplest form of designating the quality of the radiation employed.

measuring quality. In Chart 2, the experimental results have been re-tabulated. The arrangement is such that the relative advantages of each method may easily be determined. An important point not evident on the chart is the practical difficulty encountered with some of the methods. This is especially true if an absorbing medium of high atomic number is employed in measuring the rays of long wave length. We have reference to the handling of fine thicknesses of metal demanding micrometric

all measurements of unfiltered radiation below 200 K.V., copper in hundredths of a millimeter thickness is required. There are further difficulties in attempting the measurement of small intensities of radiation, as encountered in Methods C, E, and F (Chart 2).

The percentage of variation of the transmitted intensity, with the shorter wave length, is especially small as applied in Method F.

From a detailed study of these data, it

THE RELATION OF THE HALF VALUE LAYER IN ALUMINUM
TO THE HALF VALUE DEPTH IN WATER PHANTOM

Half Value In cm. Depth of Water
(by Ionometer thru Large Portal)

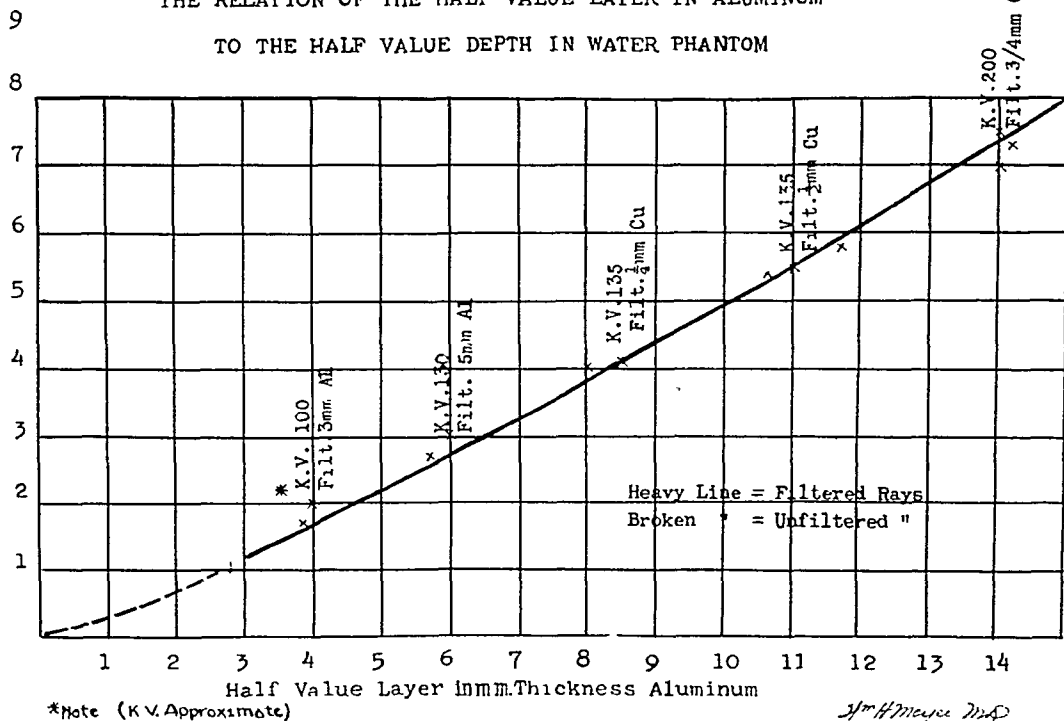


Chart 4. In deep therapy dose estimation, the close relation of the half value centimeter depth and the $d \frac{1}{2}$ in mm. Al is of definite value, since, at each half value layer, the absorption in each 2 mm. Al is almost equivalent to that of each 1 cm. of water (when large portals of entry are employed).

Water phantom measurements by ionization with back-scattering.

The half value layer, in aluminum, measured in air.

will become apparent that the heavier absorbing media, suitable for testing strongly filtered rays, offer serious difficulties in measuring rays of long wave length. Conversely, fixed lighter absorbing media give too narrow a range with rays of short wave length.

It may be worthy of mention further that, in existing tables, the Ångström units as indicated have reference to homogeneous radiation, whereas the practical roentgen therapist is dealing mostly with a heterogeneous beam. Therefore, rather wide variations occur, depending upon the method employed in calculating the wave length, indicated in the relation of Scales D, E, and F, as compared with the effective wave lengths given in Line G (Chart 2).

The lack of continuity and the disparity

in wave lengths, noted in Line G, are due to the change in method of determination as indicated. It will be observed that the rays of longer wave length have been derived from Method D, in which the percentage transmitted through 4 mm. Al has been measured. Even here, this thickness of aluminum will be found to be too great for practical purposes in attempting the measurement of transmitted radiation intensity below 150 K.V. unfiltered. For a similar reason, the effective wave lengths of shorter rays, as derived from Methods E or F, are entirely impractical of application when the Ångström wave lengths are above 0.17.

It might be well to mention here that, for the practical roentgenologist, there is as yet no simple and direct method of determining the effective or average wave lengths. The

latter are usually derived from chart or scale deduction through some more or less complicated intensity or absorption measurements (6).

plex, heterogeneous radiation employed in the average diagnostic and therapeutic x-ray department is vastly different from the supposedly homogeneous Ångström wave

COMPARATIVE RELATION
of the
Half Value Layer to the Kilovolts and \sqrt{V}

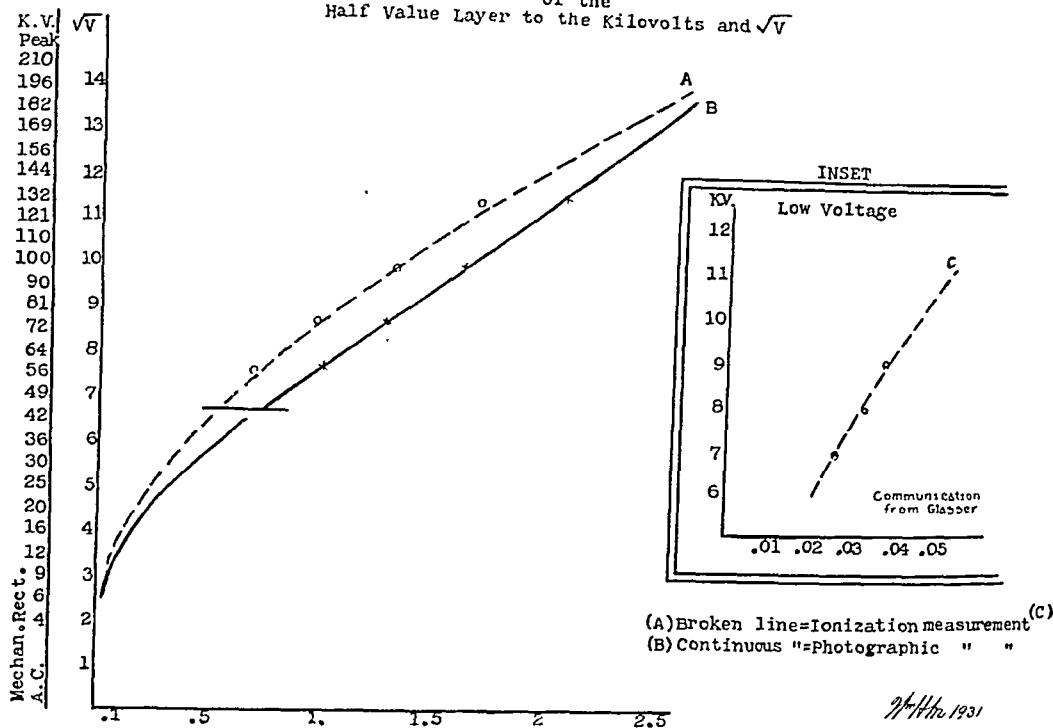


Chart 5. This chart is for the purpose of showing the approximate relation of kilovoltage to the half value measurements both by ionization and the photographic method.

The data were obtained by using mechanically rectified A.C. current and a Coolidge universal tube. In charting curves A and B, the equivalent of 0.25 mm. Al as a filter was used, the measurements under these conditions extending from 50 K.V.P. upward. Below this voltage, the curves are only relative.

(For lower voltages, we refer to the insert in which the half value measurements in relation to low voltages have been transcribed from a communication by Glasser.)

The data on the main chart have repeatedly been reduplicated on the same installation with less variation than 0.20 mm. Al in the half value measurements.

In re-duplicating these data on other installations, especially of the valve tube rectified type, a definite shift in the relation of the curves to the K.V.P. measurements will be observed, the half value measurements usually being considerably higher in relation to any of the given voltages. In other words, according to our observations, the whole peak voltage quotations could be lowered approximately 10 per cent from the figures given on the chart, the curves thereby holding the same relative position as here indicated.

Naturally, far wider variations have been, and will be, obtained with different tubes on different installations. This, however, is a further reason for recommending a substitution of half value measurements for any other method of quality designation.

The establishment of the minimum wave length is no criterion of either the average or effective wave length. Thus, again, variations and confusion arise according to the quotation and method pursued. One should further heed the fact that the com-

length quotations appearing in the physicist's laboratory data.

By force of necessity, brought about by the requirements of concise teaching, the author devised and described (7) an instrument for the purpose of photographically

determining the transmitted intensity or absorption through fixed substances. This instrument is thoroughly applicable for such deductions as are indicated in Methods C and D on Chart 2, including any variations thereof, and covering also Methods E and F.

It is, of course, possible to state directly the percentage of radiation transmitted through fixed media. This method, a short-cut procedure sometimes employed in the calibration of different installations, may, for relative comparative purposes, be justifiable. The method, however, has the same limitations indicated in Methods C, D, and E in Chart 2, with the added necessity of employing variable thicknesses of absorbing media for widely different ray qualities.

Though a most comprehensive method of qualitative study is afforded by the creation of transmission or absorption curves, the method is rather complicated. It requires numerous measurements, under rather difficult conditions, and, except by translation through charts, does not lend itself to readily communicable, simple statement.

THE HALF VALUE LAYER AS PREFERENTIAL QUALITY MEASURE

Yielding to the desire for greater simplicity and clarity of presentation, which would combine inexpensiveness with reasonable accuracy of execution, the photographic method of estimating the half value layer in aluminum, as here devised, was re-adopted. As the years pass by and my experience with class instruction continues, the conviction of the value of the method has become so strong that some simpler and more accurate method will have to be presented ere we discard the half value method.

As a foundation for our argument, may we re-quote our belief in a statement accredited to Christen (1) many years ago, and not yet refuted: "Eventually all quality determinations of the roentgen rays will have

to be calibrated against the half value method."

It is unquestionably true that, in expert hands, the ionometric method of determining transmitted intensities or the half value layer affords greater accuracy than any other procedure. However, repeated comparative tests with the photographic method have revealed such uniformity as to suggest that this procedure is sufficiently accurate for orientation purposes.

The photographic method of determining the half value layer has the further advantages that, when the control of the exposure is reasonably correct (within the wide limits of photographic readability), then interpretation and quotation are made directly from a single film. Each film is a permanent record permitting protracted study and preservation for review and future comparison. On different tests, variation in intensity is of no serious consequence. Though uniformity of photographic intensities is desirable and attainable, by variations of the time or distance factors in the formula $\frac{AXV^2XT}{D^2} = 1$, it is not absolutely essential.

One of the most important points deserving of reiteration is that the readings are made directly and quoted as such, *i.e.* ($d \frac{1}{2}$ in mm. Al), meaning the half value layer in millimeters of aluminum. Neither comparative charts nor transcription is required.

The half value method, by ionization or photographically, especially with aluminum, can be used over a considerable range of wave lengths with the least number of the objections mentioned. Though the determination of the half value layer in copper with the rays of shorter wave length has certain scientific advantages, there is either the difficulty of handling extremely thin layers (as previously mentioned) or the necessity of substituting another medium for measuring the soft rays, thus introducing double, or even multiple, standards.

The advantages of using the half value layer in aluminum as a quality measure appear to be:

1. But a single type of absorbing medium is applied throughout the full range of wave lengths.

2. Simplicity of statement, with a single unit standard, avoiding transcription.

3. The method is reasonably simple of application and, for practical purposes, affords sufficient accuracy over a wide range of wave lengths (3, 5).

Should greater accuracy be desired, the preliminary establishment by the photographic method of the half value layer as a guide will determine, within a fraction of a millimeter, the thickness of the substance. Final check may be done by the iontoquantimeter. The number of experimental test readings to be made with the iontoquantimeter is thus reduced materially. With a little practice and experience, the photographic determination of the half value layer will be found to parallel closely the results obtained by the iontoquantimetric method. For practical purposes, the photographic method would appear to suffice for orientation in the average radiologic laboratory.

Chart 3 is inserted to illustrate the simplicity with which the designation of the half value layer permits of simple definition of an otherwise complex procedure. When such transmission curves are established by ionometric measurements, then it is necessary to determine at least three points with any given quality of radiation: (1) Without the absorbing medium; (2 and 3) two or more readings with progressively increasing thicknesses of absorbing medium.

By the photographic method a direct reading of the half value layer is attainable.

THE RELATION OF THE HALF VALUE LAYER TO DEEP THERAPY

By comparing the 50 per cent intensity level on various isodose charts (derived

from water phantom measurement)⁵ with the half value layer in millimeters of aluminum (Chart 4), a remarkably useful curve will be observed. It will be found that, with filtered rays (beyond the second centimeter depth), each 50 per cent intensity level as measured in water, with different voltages and filtration, is roughly equal to one-fifth the thickness of the half value layer as measured in aluminum. In other words, the absorption through each 1 cm. depth of water is closely equivalent to that through 2 mm. of aluminum (under the conditions mentioned). Therefore, a definite relation between the measured quality of radiation and the depth dose can be established. Around this fact our method of dose calibration has been built. Above all, we have the ability to refer to and completely re-establish and duplicate any dosage that was employed during the more than 20 years of use of this quality method of measurement.

CONCLUSION

The half value layer, because of its simplicity, is a most valuable method of quality definition and is deserving of universal adoption.

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⁵Large portals (20 X 20 centimeters).

gen Dose Estimation. New York Med. Jour., Dec. 11, 1920.

DISCUSSION

MR. R. B. WILSEY (Rochester, N. Y.): Dr. Meyer referred briefly to some photographic determinations of half value layer, and, in the discussion, the photographic method has been given considerable additional attention. It seems desirable, therefore, to utter a word of warning regarding the use of photographic materials for measurements of radiation intensities.

This morning, Dr. Failla pointed out the distinction between precision and accuracy in ionization measurements, showing that extraneous effects arising from the design of the ionization chamber could influence greatly the reliability of the results, even though the instrument were carefully used and the readings precisely made. A similar distinction applies to the use of photographic materials for intensity measurements. It is much more difficult to avoid the difficulties inherent in photographic measurements than it is in ionization measurements. Sometimes the photographic method offers the only practicable possibility of making the measurements desired; in such cases, useful results can generally be obtained if the necessary precautions are followed and the interpretation of the results is properly restricted. Therefore, while photographic methods of measurement may be used under special circumstances, they are not to be recommended for general application in the measurement of radiation intensities.

Most of the half value layer data reported by Dr. Meyer, and those on which he placed greatest emphasis, were obtained with the ionization chamber, and quite properly so, since the ionization method is much to be preferred to the photographic method for this purpose.

DR. I. S. TROSTLER (Chicago, Ill.): My impression is that Dr. Meyer is not advocating the photometric method of dose determination, *per se*, with any idea that it will or should supplant the ionization method, but that he is presenting it as an easy and readily applied means of determining the half value

layer dose, particularly for use in more or less superficial therapy.

As such, it appears to me to be not only easy of application without expensive and delicate instruments but also another and additional method of recording data capable of aiding in the defense of malpractice suits.

During the last three or four years, not a month has passed in which I have not been asked for advice in the defense of damage suits. I am sorry to say that, in the great majority of them, the only method of dosage computation or determination is the milliamperage, voltage, distance, time, and filter, and almost invariably, the voltage used must be guessed from the spark gap, from points of various acuity. If all of these defendants had applied some such simple means of measurement of the dosage as the photometric method outlined by Dr. Meyer, most of these damage suits would assume a very, very much less formidable aspect. I mean that the defendant physicians would be able to testify that some accurate means of dosage measurement had been applied during or before the application of the treatment complained of, and expert testimony might be introduced to verify properly the correctness of the dosage used. So that, aside from the actual scientific and therapeutic value of the photometric method in the determination of the dosage to be administered, as presented by the essayist, its use has great possibilities of being valuable as another means of recording dosage, to help us in defending damage suits charging malpractice.

Because of the multiplicity of malpractice suits being filed, may I again urge all who use roentgentherapy to keep careful records of the technic and dosage applied in every instance, and the figures and methods of dose determination. We do not know who will be next to be served with notice that suit has been started, so we must constantly bear in mind that "Eternal vigilance is the price of liberty," even when discussing roentgentherapy.

DR. MEYER (closing): From the discussion, it is evident that some of the gentlemen

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⁵Large portals (20 x 20 centimeters).

was employed only in conjunction with the other usual therapeutic measures; this fact renders any claim, at this time, for its specific action out of the question. However, it is acknowledged by all unbiased observers (1, 2, 3) that roentgen treatment of many localized infectious processes, due to other types of organisms, has been so definitely beneficial in the past that to neglect its use in gas bacilli infection may truly be considered poor judgment. In fact, x-ray treatment of these localized infections has been so successful and the results so widely published for the past twenty-five years or more that it seems unnecessary to make a plea for its use in such a fulminating and serious infection as gas gangrene usually proves to be. However, the use of the x-ray as an aid in the treatment of localized infections seems to have escaped the attention of many sincere practitioners. Since gas gangrene has not been mentioned specifically in this connection, is it not but fair that this form of treatment be called to the attention of those not engaged regularly in the practice of radiology?

No animal experimentation has been completed as yet, and, judging from recent events, valuable time may be lost by waiting on such procedures. The experimental laboratory work now in progress on the treatment for gas gangrene and tetanus infection by the Radiological and Pathological Departments of the School of Medicine, Creighton University, will be reported at a later date. In the meantime, in the treatment of a serious infection, any simple measure which does not interfere with other indicated measures, is not inherently dangerous, and appears to be beneficial on all occasions, should be employed regularly regardless of possible lack of confirmation from the laboratory.

In this preliminary report roentgentherapy is recommended merely as an aid in the treatment of gas gangrene infection, with

the hope that it will be used as such wherever it is indicated. It does no harm, is easily applied, is accessible to all, and apparently does some good. In at least three instances in this small series, amputation was deferred to see what action x-rays would have. Amputations were unnecessary in these three cases, as improvement followed immediately after the first x-ray treatment, and all the patients recovered.

CASE REPORTS

Case 1. F. P., farmer, age 21 years, entered the hospital on Aug. 30, 1928, with a laceration below the right knee, following an auto accident. Clinically the infection which followed looked like gas gangrene. The laboratory cultures were positive for *Bacillus welchii*, and x-rays films showed considerable gas in the soft tissues. Amputation was advised by consultants, but action was deferred to see the effects of the other treatment. Serum and x-ray therapy were administered. No amputation was necessary and the patient was dismissed after seven weeks' hospitalization.

Case 2. J. B., schoolboy, age 10 years, entered the hospital on Aug. 24, 1930. He had been injured by stepping on a nail, which penetrated deeply into the tissues of the left os calcis area. Antitetanus serum was given immediately. Two days later the wound had the appearance, odor, etc., of gas gangrene; cultures of the wound were positive for *Bacillus welchii*. X-ray treatments were started after amputation had been strongly advocated by several consultants. The patient improved rapidly and no amputation was necessary. He was dismissed after three weeks' hospitalization.

Case 3. K. B., laborer, age 23 years, entered the hospital on Nov. 15, 1930, following an injury while blasting with dynamite. Some had exploded prematurely, and the

have missed the point of the presentation. It was not intended to evaluate the photographic *versus* the ionization method for intensity measurements. As a matter of fact, all of the data in the charts presented (except when specifically mentioned) were obtained by ionometric measurements.

If the ideal and perfect method of quality determination existed, this presentation would not have been required. As matters stand, the definition of quality by means of the half value layer (expressed as $d \frac{1}{2}$ in mm. Al) appears the most logical. Whether this information be derived from absorption curves or direct half value measurements is immaterial, so long as uniformity of procedure and expression is established. As an absorbing medium, aluminum has a greater

range, especially in the longer wave lengths, and can be used practically throughout the length of the scale, though copper may afford greater accuracy with the shorter wave lengths.

The creation of a uniform standard of voltage measurement is most desirable, but the need for direct radiation quality determination still remains. Insofar as the photographic method of establishing the half value layer is concerned, with reasonable experience, a remarkably useful parallelism will be found between these measurements and those obtained by ionization.

Until some such method of quality definition as here presented is accepted, the present-day chaos will continue.

THE X-RAY AS AN AID IN THE TREATMENT OF GAS GANGRENE¹

Bacillus welchii INFECTION—PRELIMINARY REPORT

By JAMES F. KELLY, M.D., Associate Professor of Radiology,
Creighton University Medical School, OMAHA, NEBRASKA

LATELY it has come to the attention of the writer that a six-year-old boy had an arm disarticulated at the shoulder for a gas bacillus infection in the forearm, and that two deaths have occurred within the last three months in nearby hospitals from the effects of this infection, in spite of the usual frantic surgical and serologic efforts to effect a cure. The end-result in these cases was undoubtedly unavoidable yet within three years the writer has observed six cases involving the extremities which have all seemed to be benefited by the use of small doses of the x-rays. Five of the six cases were seen in St. Catherine's Hospital, where the first case was treated with x-rays on Aug. 1, 1928, and where this method of treatment is now used, in

addition to other measures, on all gas gangrene cases. The writer is, therefore, taking the liberty of reporting these few cases with the idea that, if there is any value in this form of treatment, it may be used when necessary, as everyone has access to x-ray apparatus and no special knowledge is required for applying the mild dosage used by the writer.

One naturally hesitates about reporting any results on such a small series. However, the condition is not met with frequently enough in time of peace to warrant a longer wait in order to accumulate a larger number of cases. If the method has any merit, it is offered here so that many others may have an opportunity to use it, and so that its value, if it has any, will be more quickly established. Furthermore, roentgentherapy is not offered as a specific. In every case it

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

plete, as only a few facts were given to the writer by the attending surgeon. A boy, age 6 years, who lived in the country, fell on June 1, 1931, and received a compound fracture of the bones of the forearm. Gas bacillus infection set in and the arm was amputated as soon as the diagnosis was made. The patient lived. No x-ray treatment was given as the surgeon stated emphatically that he had never heard of such a thing. This man is a surgeon, not a general practitioner who does surgery. He stands very high in his community, is a member of the strongest surgical association in this country, and is the chief of a surgical staff in one of the largest hospitals in Nebraska. He has no objection to using the x-ray in such cases if he thinks it will do any good. The value of the x-rays in localized infections is apparently not as well known as the radiologist believes, and this must be the radiologist's fault.

Case 9. J. F., age 8 years, entered the hospital on June 18, 1931, following a compound fracture of the left forearm. When he was admitted to the hospital two days after his injury the laboratory report was positive for *Bacillus welchii* and the x-ray films showed some gas scattered through the soft tissues about the fractured bones. Consultation was called and amputation advised. The use of serum and x-rays, at least temporarily, was decided upon. The boy immediately improved and amputation was not necessary. He left the hospital after a severe serum reaction, which caused considerable discomfort.

TECHNIC

The technic of the treatment used in Case 4 is stated below as the patient was one of the most seriously sick individuals of the group and the response was typical.

He entered the hospital on Jan. 8, 1931,

and x-ray treatment was started on January 12, using the following factors:

Mobile x-ray unit: 5-30 radiator type of tube
5-inch spark gap (approximately)
5 milliamperes
15-inch distance (approximately)
0.5 millimeter aluminum filter
3 minutes over each area treated, operating the tube 30 seconds, allowing it to cool for 30 seconds, and repeating this procedure until the full time was given.

January 12, morning	left femur, anteriorly	3 min.
January 12, afternoon	left femur, anteriorly	3 "
January 13, morning	left femur, anteriorly	3 "
January 14, morning	left femur, anteriorly	3 "
January 14, morning	left femur, posteriorly	3 "
January 15, morning	lower femur	3 "
January 15, morning	upper thigh and groin	2 "

No other case received as much dosage as this one. Most of them received 3-minute doses twice the first day, twice the second day, once on the third day, and once again on the fourth day, with the other factors as stated. All tissues suspected of involvement should be irradiated. If it is not possible to cover them at 15-inch distance (no cone), the tube should be moved and some overlapping on the areas allowed. Care should be taken that the filter is not left out. There should be no danger from the above dosage.

THE ACTION OF THE RAYS

Any attempt to explain the action of the x-rays in treating localized infections necessitates a consideration of the fundamentals of the useful characteristics of the x-rays. Briefly, they are:

1. They are capable of penetrating objects opaque to ordinary light. The ability to penetrate is in inverse proportion to the density of the object (physical action).
2. They are capable of causing a chemical change in the emulsion of an unreduced photographic film (chemical action).
3. They are capable of causing fluorescence by striking certain crystals (physical action).
4. They are capable of exerting a stimu-

face, right arm, and left leg were badly injured, and the right hand was missing. The débris at the lower part of the right forearm received surgical attention and tetanus antitoxin was given. Two days later, cultures of the wounds in the left leg area were positive for *Bacillus welchii*. Gas bacillus serum was administered and x-ray treatments were given over the left leg and the stump of the right arm. The patient recovered, with no further loss of extremities, and was dismissed after five weeks' hospitalization.

Case 4. C. H., merchant, age 42 years, entered the hospital on Jan. 8, 1931, with the bones of the left leg shattered by a bullet wound just below the knee. Cultures from the wound showed positive *Bacillus welchii* infection, and x-ray films showed considerable gas in the soft parts. Serum was given. The leg was disarticulated at the knee, but the infection progressed up the limb, and all the tissues to the hip were swollen, crepitant, and discolored at the time the first x-ray treatment was given. Improvement began with the x-ray treatments and, four days later, the patient was free from evidence of active gas bacillus infection. He was dismissed after eight weeks' hospitalization.

Case 5. This record was secured from a nearby hospital. The patient, who did not receive x-ray treatment, died. The man, who was 51 years of age, was admitted to the hospital on Feb. 2, 1931, suffering from a compound fracture of the os calcis. A prophylactic serum against tetanus and gas bacillus was administered and local surgical measures were immediately used to clean up the wound. On February 6, there appeared to be a gas bacillus infection present; the laboratory report confirmed this opinion. Immediately 100 c.c. of regular serum were given intravenously. At each 12-hour interval thereafter, he received a dose of 10 c.c. of concentrated serum, totaling 50 c.c. con-

centrated serum in addition to the prophylactic dose. The patient received no x-ray treatment. He died 56 hours after admission to the hospital, in spite of these surgical and serological measures.

In this case a prophylactic dose of serum was given, in addition to thorough local surgical measures at the time of the injury. During the progress of the disease the case was handled by an orthopedic surgeon with considerable experience in treating this infection during the World War. The fatal termination should impress upon us that any help we are able to secure in a fight against this infection should be welcome.

Case 6. C. H., age 61 years, was admitted to the hospital on April 1, 1931, suffering from an injury to the left ankle area when he fell from a tractor. Clinically there appeared to be a gas bacillus infection present. The laboratory report was positive for *Bacillus welchii*. Amputation was immediately performed and serum administered, but apparently the infection was not entirely checked, and a second amputation was performed. After the second amputation, roentgentherapy was used and the patient recovered. He was dismissed after six weeks' hospitalization.

Case 7. H. B., age 82 years, was admitted to the hospital on April 14, 1931. The patient, who presented a strangulated hernia, was immediately operated upon. On April 20, complications suggestive of gas bacillus infection were noticed, after the patient had apparently rallied from the operation and was on his way to recovery. Cultures taken from the wound showed gas bacillus infection. Gas bacillus serum was immediately administered. Many other general measures were used in addition to the serum, but the patient died. He had received no x-ray treatment.

Case 8. The history on this case is incom-

plete, as only a few facts were given to the writer by the attending surgeon. A boy, age 6 years, who lived in the country, fell on June 1, 1931, and received a compound fracture of the bones of the forearm. Gas bacillus infection set in and the arm was amputated as soon as the diagnosis was made. The patient lived. No x-ray treatment was given as the surgeon stated emphatically that he had never heard of such a thing. This man is a surgeon, not a general practitioner who does surgery. He stands very high in his community, is a member of the strongest surgical association in this country, and is the chief of a surgical staff in one of the largest hospitals in Nebraska. He has no objection to using the x-ray in such cases if he thinks it will do any good. The value of the x-rays in localized infections is apparently not as well known as the radiologist believes, and this must be the radiologist's fault.

Case 9. J. F., age 8 years, entered the hospital on June 18, 1931, following a compound fracture of the left forearm. When he was admitted to the hospital two days after his injury the laboratory report was positive for *Bacillus welchii* and the x-ray films showed some gas scattered through the soft tissues about the fractured bones. Consultation was called and amputation advised. The use of serum and x-rays, at least temporarily, was decided upon. The boy immediately improved and amputation was not necessary. He left the hospital after a severe serum reaction, which caused considerable discomfort.

TECHNIC

The technic of the treatment used in Case 4 is stated below as the patient was one of the most seriously sick individuals of the group and the response was typical.

He entered the hospital on Jan. 8, 1931,

and x-ray treatment was started on January 12, using the following factors:

Mobile x-ray unit: 5-30 radiator type of tube
 5-inch spark gap (approximately)
 5 milliamperes
 15-inch distance (approximately)
 0.5 millimeter aluminum filter
 3 minutes over each area treated, operating the tube 30 seconds, allowing it to cool for 30 seconds, and repeating this procedure until the full time was given.

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the roentgen ray to ionize or split gases. Possibly the gas formed in the tissues in this disease may be highly toxic in its original state and the rays may, through some oxidizing effect, render the gas less toxic to the host or even destructive to the organisms which produced it.

To report at any further length on these nine cases would lead to much useless repetition. Summarizing from the data mentioned above, and from the hospital records, the following facts stand out:

1. All of the patients in the series had open wounds, all had active gas bacillus infection clinically, the laboratory reported positive cultures of gas bacillus, and all were seriously ill. There were from three to six physicians in consultation on every case. In the majority of cases, gas was scattered through the tissues, but not all of the patients were roentgenographed.

2. X-rays were used as an aid to treatment in six of these nine cases. Six cases recovered without the loss of any structures other than those lost prior to the use of x-rays or incident to the original injury. Of the remaining three cases, in which x-rays were not used, two died in spite of the usual serologic and surgical measures. In Case 8, though the patient lived, he lost one arm at the shoulder.

3. Many other therapeutic measures were also used in all the cases, and in none were the x-rays used as the only form of treatment. On the whole, the line of treatment varied according to the character of the original injury. The two patients who died had surgical and serologic methods used in their behalf. The patient with a compound fracture of the os calcis (Case 5) received a prophylactic dose of gas bacillus and anti-tetanus serum before the evidence of infection appeared.

4. The ages of the individuals, all males, varied between 6 and 82 years.

CONCLUSIONS

Roentgen rays are established aids in diagnosis and in teaching (including research), but it is in connection with their status as an aid in therapy, especially in connection with the treatment of gas gangrene in conjunction with other measures, that this article has been written. Furthermore it is sincerely hoped that the widespread use of them in many cases will be as generally successful as it has been in the few cases reported here. If so, there will be fewer amputations and transfusions, a lower mortality, and, probably, the use of less serum, which sometimes leads to severe reactions and much discomfort.

ADDENDA

Since this article was written, three more cases have been treated, but with two deaths. All cases received the benefit of surgical and serologic measures, as well as roentgen-therapy. In the two patients who died, the trunk was involved while in the one who recovered the upper extremity was involved. The postmortem findings in one case may give the radiologist an idea of the treatment of these cases involving the trunk, as the pathology was undoubtedly too deeply seated for the light dosage used. Henceforth, cases in which the trunk is involved will be transported to the x-ray department, in which the use of heavier voltage and heavier filter will insure a greater depth effect of the radiation.

CASE REPORT

Case 10. M. C., male, white, age 55 years, was admitted to the hospital on Aug. 19, 1931, and died August 24. Autopsy was performed one hour after death.

Anatomic Diagnosis.—Left ischiorectal abscess with a complicated gas gangrene infection extending below the levator ani into the perineum, scrotum, penis, and lower abdominal wall, and posterior to the rectum

lating or destructive action on living cells, depending upon the amount of radiation received (biologic action).

5. They are capable of rendering gases conductive to electricity (ionization—physical action).

The power of the rays to penetrate the tissues may be of value, as we are attempting to reach a living organism or its toxins situated deeply in the muscles.

The second characteristic is the power of roentgen rays to cause chemical changes. It may be that some chemical changes take place in the tissues which render them unsatisfactory hosts to the anaërobic saprophytic, etc., organisms, which require a particular type of surroundings for existence.

The third characteristic mentioned is the power of x-rays to cause certain crystals to fluoresce. Since the organisms are unable to tolerate air (anaërobic) is it not possible also that they do not tolerate a wave length such as that of the roentgen ray, which may in itself be harmful? Or may the rays be changed by some substance in the tissues (as they are changed in the case of fluorescence) to produce a wave length of such a nature as to be inhibitory to the welfare, or possibly even destructive, of the organisms?

The fourth characteristic is the power of x-rays to cause a biologic action when they are directed on living cells. One may think of several ways in which this action may be of value in the problem we are considering, but much work must be done before the correct solution is obtained. The ray, acting in a destructive capacity, may kill the organisms themselves, or it may act as a bacteriostatic and, by preventing their propagation, bring their biologic course to an end. On the other hand, when it is acting in a stimulating capacity the beneficial action of the roentgen ray may be on the cells of the host, stimulating them to superior defensive powers which, in the end, eliminate the invading organism. Many variations or combinations

of the above-mentioned possibilities may be present. In this useful characteristic we have a high hurdle for our professional critics to take. They contradict themselves repeatedly and grossly here. When the radiologist recommends x-ray treatment for gas gangrene or some other type of infection, for instance a carbuncle, he is promptly told by the surgeon that the x-rays have no action in such matters, that they have no power to destroy any organisms. Shortly afterwards, this same practitioner may be overheard explaining to a patient that to take roentgen treatment for a certain condition is to incur a very serious risk as the x-rays are sometimes followed by considerable destruction of tissue; in other words, an x-ray burn may result.

The biologic action, that is, the ability of x-rays to exert a stimulating or destructive action on living cells, depending on the amount of radiation received, is a scientific and clinical fact beyond any possibility of question.

There is no claim made here that these organisms are destroyed by the use of x-rays or even that the rays act as a bacteriostatic. In fact, no claims are made. Some possibilities are mentioned and, at the same time, the inconsistencies of some of the objections to the use of the x-ray in the treatment of infections are pointed out. The dishonest practitioner claims it will not harm even a bacterium in one instance; he then explains to a prospective patient how powerful it is and what great harm roentgentherapy would surely do if it were tried in the next instance. At any rate, the writer has had an opportunity to treat a few cases of gas gangrene, after having been solemnly assured by some of the consultants that it would do no good. All the patients lived, and in no instance was amputation of a limb required from the effects of gas bacillus infection after the x-rays were used.

The fifth characteristic is the power of

fections realize that you are dealing with something almost as serious as cutting the aorta in nephrectomy. You practically throw up your hands and say there is absolutely nothing that can be done. In 1918, Dr. Bull had success in making a serum which was effective in the treatment of gas bacillus infection, but he reported that bacillus of malignant edema was nearly always present when *Bacillus welchii* was present.

I think that Dr. Kelly's paper is most timely. If he had reported it sooner, he might have done something more in saving the three patients who died, because the physicians in charge undoubtedly did not know the value of roentgentherapy.

DR. C. S. BUCHER (Champaign, Ill.): I would like to ask the essayist regarding the voltage. My understanding is that he uses a very long wave length. We have done some work, as a great many others have, with bacteria in culture media. We find that we can expose the culture media to short wave lengths or long wave lengths; we can give large doses or small doses, yet the bacteria still grow.

However, in living tissue, we do get results. We have cured quite a few cases of carbuncles, boils, and other infections. Recently we treated a few cases of infections of the upper lip and nose with very good results. Dr. Clark, of the University of Illinois, says the effect in the tissue is due to ionization. Of course, if we figure on the effect of electrons in living tissue, we will probably have a different result there than we obtain in culture media. Someone has suggested planting the bacteria in ordinary meat and letting them grow, then using x-rays to get results. I do not know how true that is, but I am going to try it.

There is one way of conveying this information to the general practitioner, and that is through the medical journals the general practitioner reads. I have had the opportunity, just recently, to write a few papers for one of the medical journals that is not read exclusively by radiologists. However, it is read by the general practitioners, so I address them.

DR. KELLY (closing): Gas gangrene seems to be on the increase in our neighborhood, not only in St. Joseph's and St. Catherine's hospitals, but in the neighboring hospitals as well. I do not know whether it is because we are looking for it and find it oftener, or just what is the reason. But I do not see how anybody could miss the cases we saw. They announced themselves, as you could smell them in the hall, and the cultures were positive in all.

Although I did not see these cases in their early stages, they developed fast. Our x-ray department is like any other—we get to treat cases when the rest of the staff wants to step aside.

Dr. Johnston brought up the question of early report on this work. I did feel quite badly about the six-year-old boy losing his arm, as he was from a town only 60 miles away and an earlier report might have prevented the amputation.

The voltage used is ridiculously low, but the only thing with which I could reach the patient was the mobile unit. It is a regular 5-30 unit with a small radiator tube attached, so the voltage used is about 80 kilovolts.

I believe I answered the question of ionization in the body of the paper. The part ionization plays in therapy is, of course, questionable. As I do not know what happens. I have answered questions in various ways, giving different reasons, because the more the question is argued, the better I like it. I have no more idea of what happens than some others do and for that reason I have encouraged discussion from every possible angle.

In regard to the diagnosis, I thought in my conclusion I reported that the majority of the cases had gas scattered through the tissue, but there were two which were not radiographed. All cases had positive laboratory diagnoses made by two men who had seen service during the last year in France and were familiar with gas gangrene, Dr. F. W. Niehaus, of St. Catherine's, and Dr. B. Carl Russum, at St. Joseph's.

As to the question brought up on voltage. Get me straight on that: I think the low volt-

upward over the brim of the pelvis. The infection spread out like a fan and extended above the psoas muscles up into the right kidney fossa, across the vertebral column, and over the anterior surface of the left psoas muscle. There were acute hyperemia of the lungs, congestion of the liver and spleen, sclerosis of the coronary arteries, slight arteriosclerosis of the aorta, and post-mortem discoloration of the dependent portions of the body.

Comment.—From the above summary, it is evident that the light dose of x-rays applied over the lower abdominal region and buttocks would fall far short of having any effect on an infection which had already extended upward into the kidney fossa and crossed to the other side anterior to the psoas muscle. The findings indicate only that, if the trunk is involved, heavier radiation should be employed before any conclusions are drawn as to the value of roentgen-therapy in gas infections.

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DISCUSSION

DR. W. A. JOHNSTON (Dubuque, Iowa): This paper is of unusual interest to me due to the fact that it adds one more inflammatory disease to the list of those which are benefited by x-rays. Dr. Pfahler stated that in 1906 he treated by x-rays a patient suffering very severely with arthritis and obtained improvement. I think that is about the earliest record we have of any inflammatory treatment by x-rays, although there may be earlier ones. In 1918 or 1920, Dr. Hickey did a great deal of work in treating diphtheria carriers with x-rays, reporting remarkable success.

However, as a whole, progress in our treat-

ment of inflammatory conditions, roentgen-therapeutically has progressed very, very slowly. There have been many ups and downs, partly due, I think, to the fact that we have had no scientific way of proving what the action of the x-rays is in the inflammatory tissue, and we are still dealing, in great part, with theories.

There are a few conditions, however, that survive all of the criticism that has been offered during this interim. I think we will all agree that there is improvement in the treatment of acne and boils; also that erysipelas is improved by exposure to x-rays. Dr. Langer has spoken of the marked improvement in the arthritic condition he is obtaining by the roentgen treatment of the vegetative nervous system.

Only a few weeks ago, Dr. Grant, from Rockford, Illinois, told me that he was obtaining much improvement in treating trifacial neuralgias by exposing from each direction the region of the gasserian ganglion. Of course, that probably would be an effect similar to the one Dr. Langer reports in his treatment of arthritis. In other words, it seems that we are returning to our position of some 10 or 15 years ago, and these cases are being reported because actual results are being obtained.

Dr. Kelly has told us of the improvement, or rather cure, that he has obtained in cases of gas gangrene. I do not think that Dr. Kelly needs to apologize in any way for reporting only six cases treated. I do not know whether I am wrong or not, but I do not believe there are more than two or three other men in the United States who have seen as many as six gas gangrene cases within a period of three or four years. In my experience at the University of Michigan, and in my present practice—we have a moderately large industrial practice and a large community of farmers—I have seen only one gas gangrene infection. There are undoubtedly some who have seen more, but I do think it is a remarkable record to be able to bring us a report of six cases treated; and especially six cases which have been treated successfully.

You who have seen these gas bacillus in-

RADIUM IN MEDICAL USE IN THE UNITED STATES¹

By R. R. SAYERS, M.D., Chief Surgeon, U. S. Bureau of Mines; Surgeon, U. S. Public Health Service, WASHINGTON, D. C.

RADIO-ACTIVITY, the property of radium that led to its isolation more than thirty years ago, is the characteristic that makes it of value in the treatment of disease. Tyler² gives the following brief history of the investigation:

"The way to the discovery of radium was opened in 1895 by Roentgen, who found that the glow from a Crookes tube contained penetrating rays, which he called x-rays. Prof. Henri Becquerel, while investigating the effect of various phosphorescent substances, found that uranium salts produced photographic impressions even when enveloped with opaque substances. To Marie Sklodowska, a young Polish student, who later became Madame Curie, Prof. Becquerel delegated the task of learning how and why uranium possessed power to emit these peculiar rays, which he had proved to be electrical in character. Madame Curie, examining by electrical methods the radio-activity of a large number of minerals containing uranium and thorium, discovered that some specimens of pitchblende had about four times the activity of the metal uranium; that chalcocite, the crystallized phosphate of copper and uranium, was twice as active as uranium; that autunite, a phosphate of calcium and uranium, was quite as active as the same weight of pure uranium. In order to check these discoveries, she prepared chalcocite artificially, starting with pure products, but found that this artificial chalcocite had only the activity represented by its composition, or, roughly, 40 per cent of the activity of uranium. This led to the conclusion that there was some element or substance in the residue from uranium minerals that possesses a high degree of activity. After an exhaustive chemical investigation of pitchblende from Joachimsthal, she found that this mineral contained

not only uranium but also another radio-active substance, to which she gave the name of polonium, in honor of her native land. Later in 1898, Monsieur and Madame Curie found still another element, which, when brought to a state of concentration, was several million times as active as uranium, and to this was given the name of radium. Debierne afterwards found a fifth radio-active substance, actinium, and in 1906 Boltwood isolated the metal ionium. Strictly pure radium chloride was first produced in 1902."

The first radium was produced commercially from the uranium residues obtained from the mines of Joachimsthal, Bohemia. Tyler calls to attention that, as the ores were a government monopoly, search was begun at once for sources in other parts of the world. As a result, radium-containing ores have been found in about ten countries.

The interest of the Bureau of Mines in the efficient recovery of radium extends back to about 1912. Under an agreement with the National Radium Institute³ the Bureau built and, in June, 1914, began the operation of a radium-recovery plant at Denver, Colorado. By the time the work ceased in January, 1917, 8.5 grams of radium had been produced. The methods devised by this investigation reduced the cost of recovering radium to about one-third of the then current prices. F. L. Hess, principal mineral technologist of the Bureau of Mines, states⁴ that at the present only two countries are producing significant quantities of radium—the Belgian Congo at Chinkolobwe, Katanga, and Czechoslovakia at Jachymov (formerly St. Joachimsthal). In 1922 there was an important development in

¹Reprinted from U. S. Bureau of Mines Information Circular 6667. Read before the Seventeenth Annual Meeting of the Radiological Society of North America, at St. Louis, Nov. 30-Dec. 4, 1931.

²Tyler, Paul M., Radium Inf. Cir. 6312, Bureau of Mines, 1930, 55 pages.

³The National Radium Institute (Inc.) was a corporation organized and existing under and by virtue of the laws of the State of Delaware for the study of the best methods of producing uranium, vanadium, and radium.

⁴This statement is contained in a chapter prepared for publication in Spurr and Wormser's "Marketing of Metals and Minerals."

age is all right in the cases in which the infection is localized in the extremities, but I lost one with trunk involvement at the County Hospital and one with trunk involvement at St. Joseph's Hospital and I felt it was because I did not use enough voltage. I am satisfied that higher voltage is necessary in trunk involvement, but I do not know its exact status.

DR. C. E. PIERSALL (Reno, Nevada): The doctor did not say a word about making a roentgenographic diagnosis of these cases. That was brought out at the Los Angeles meeting last year, at which there was a nice display.² I think it is opportune to ask the Doctor if he found characteristic signs on the x-ray films in all these cases, or if he used the roentgen ray to diagnose gas gangrene. In the last four or five months, I have had two cases that we diagnosed roentgenographically before they were diagnosed otherwise. I believe that it can practically always be done very early.

DR. GAGE CLEMENT (Duluth, Minn.): In case of accident, how do you differentiate on your x-ray film between gas gangrene and subcutaneous emphysema?

DR. PIERSALL: Others can give you more information on that. But I see the bubbles entirely away from the punctured wound, located between the tissues, sometimes, in both directions from the wound.

DR. D. A. RHINEHART (Little Rock, Ark.): It was my brother who read the paper mentioned by Dr. Piersall. He and I worked this problem out together.

The agricultural regions of Arkansas, around Little Rock, seem to be filled with this bacillus, as well as the bacillus of anthrax. In Little Rock, we had a number of these cases. We have four hospitals on our visit-

ing list there and we see these patients two or three times a month. In two different hospitals we discovered this gas dissecting itself along the muscle and tissue planes spontaneously. We compared notes on them and finally collected this clinical material that was exhibited at Los Angeles, which formed the subject for the paper.

The diagnosis is very easy, providing always that the films are of good quality. I allowed a technician to make a film of an open wound in a patient; however, the film was over-exposed. Later, in collecting the clinical material, we reduced the film with reducing solution, and found bubbles of gas in the muscle planes which I had missed in the first place because of the over-exposure.

The bubbles are very easy to see. In any case in which there is gangrene, they will occur within from 6 to 24 hours. The diagnosis can always be made by roentgenographic examination much quicker than by any other method before the patient really has any clinical symptoms, or there are clinical findings.

Although we see so many cases of it, we have had no experience in the treatment of gas gangrene. If there is any place in the country in which x-ray treatment should be of great benefit, if it is as good as Dr. Kelly says, that place is Arkansas.

DR. W. L. ROSS (Omaha, Neb.): I wish to confirm the diagnostic value of x-rays in this lesion. Dr. Kelly will recall that, perhaps some six or seven years ago, Dr. Tyler had occasion to demonstrate the peculiar air lines which stand up like air in any other part of the body, dissected up alongside the muscles. They are characteristic from the diagnostic standpoint. I have had experience in only one case, five or six years ago, and obtained the same findings. The air line could be very readily seen dissecting in between the tissues and up along the muscles. I am sorry to say that I did not get a chance to treat the patient, although I suggested the idea.

²Rhinehart, D. A.: Air and Gas in the Soft Tissues: A Radiologic Study. *RADIOLOGY*, December, 1931, XVII, 1158-1170.

sult, the Deutsches Zentralkomitee zur Erforschung und Bekämpfung der Krebskrankheit and the Reichsausschuss für Krebsbekämpfung agreed on certain criteria, which are set forth in a communication by Professor Friedrich: The purchase of radio-active substances should be considered only by such institutions as have an experienced radiologist for the therapeutic application of such substances. The use of small quantities of radio-active substance for the local treatment of carcinomas is the method indicated by the present status of medical knowledge, whereas the treatment *à distance* with heavy doses of several grams is a method concerning which no definitive opinion can be given as yet. Supplies of radio-active substances should be available in all university clinics and large hospitals, the amount ranging from 200 to 500 milligrams, according to the population of the area for which provision is made. Some centers should have an additional amount in order that they may serve also as research centers. Such central institutes should have an average of 50 milligrams of radio-active substance for each bed designed solely for patients to be irradiated. A central institute should have not less than twenty beds set apart for the use of cancer patients to be irradiated with radio-active substances, which presupposes accordingly the possession of 1,000 milligrams of radio-active substance. Since experience has shown that the biologic effects of the rays emanating from radium and mesothorium are of equal value, in the purchase of supplies the choice as between radium or mesothorium should depend exclusively on economic and practical considerations. The legal regulation of the application of radio-active substances for therapeutic purposes is a problem of the near future."¹⁰

In the United States, from the time that American radium factories made the first production of radium salts in 1913 to the last recorded output in 1926, they isolated about 203.3 grams of radium. Besides this production the imports of radium (Table I) in salts are shown by the customs records.

It is thought that at least 3 grams were imported previous to 1923, at which time Belgian radium began to arrive in this country. Production and imports are shown in Table I.

TABLE I

Year	Radium produced in U. S. grams	Radium imported into U. S. grams
1913	2.1	-----
1914	9.6	-----
1915	4.71	-----
1916	8.17	-----
1917	13.83	3.00 estimated
1918	22.79	-----
1919	28.648	-----
1920	32.539	-----
1921	35.693	-----
1922	24.189	-----
1923	12.212	8.75
1924	3.365	8.1
1925	2.952	9.27
1926	1.725	10.97
1927	none	7.26
1928	none	10.97
1929	none	10.69
1930	none	16.86
Total	202.523	85.87

The total production and imports into this country to the end of 1930 have been in the neighborhood of 288.4 grams. It is probable that since 1916, including use during the Great War, not more than an average of 2 grams per year has been used in luminous materials, a total of not more than 30 grams. What exports have amounted to is unknown, but they have probably not exceeded 20 grams, so that, making no allowance for broken tubes and other losses, there would appear to be still in this country 238 grams of radium. This is very much more than can be accounted for from holdings, and there may have been much larger exports than have been recorded.

The amount of radium in the United States now used for medical purposes has been variously estimated at from 50 to well over 200 grams. The following statement was published in the *Journal of the American Medical Association*:¹¹

"According to figures supplied by the

¹⁰Purchase and Distribution of Radio-active Substances. Jour. Am. Med. Ass'n., Oct. 3, 1931, XCVII, 1016.

¹¹Radium Owned by Hospitals and Physicians. Jour. Am. Med. Ass'n., June 13, 1931, XCVI, 2057.

the radium industry by the opening in that year of the radium works of the Société Metallurgique de Hoboken at Oolen, in Belgium, which soon acquired a monopolistic position. The material treated in these works was obtained from the Belgian Congo through the Union Minière du Haut Katanga. In the concessions of this company, which is primarily copper-producing, radium-bearing ore was discovered at Luiswishi in 1913 and at Chinkolobwe in 1915. . . . The present productive capacity of the Oolen works is about six grams of radium monthly. At present, the price fluctuates between sixty and seventy dollars per milligram (£12 10s. to £15), or in the region of 270 marks.⁵ These two countries now produce annually about sixty grams and three and a half grams, respectively. Besides these, seven other countries have radium deposits which, in order of size of the known deposits, are about as follows: United States, Canada, Russia, Portugal, Madagascar, England, and Australia. It is possible that the position of the first-named countries may be reversed before another year has passed. The deposits discovered in 1930 on the east side of Great Bear Lake, District of Mackenzie, Canada, are said to be the richest and possibly the largest yet found.⁶ From prospecting operations during 1931, 20 tons of pitchblende were obtained and shipped. The extractions that have been made from batches of this ore have been well over 90 per cent. The 20 tons is said to contain at least \$100,000 worth of radium at present prices.

During the past few years, the amount of radium used for medical purposes has been much discussed. In Great Britain plans for distributing and supervising the supply of radium for treatment of disease have been completed and put into effect. The first an-

nual report⁷ states that the National Radium Trust has as its chief duties: To take charge of funds raised by public subscription and voted by Parliament for the provision of radium and to arrange for the purchase of radium. The Radium Commission has the duty of making the arrangement for the proper custody, equitable distribution, and full use of the radium purchased by the Radium Trust. The Radium Commission is composed of ten members and a chairman. The Trust appoints the chairman. The Minister of Health, the Secretary of State for Scotland, the Medical Research Council, and the Department of Scientific and Industrial Research severally appoint one of the members. The remaining six members are selected by the Trust from a panel of not less than 12 persons having special knowledge and experience in the application of radium in the treatment of the sick. Up to August, 1930, the National Radium Trust had ordered 18.5 grams of radium. Of this amount, some 18 grams had been provisionally allocated to national centers; only 14 grams had been received from the radium manufacturers, and not more than 8 grams had been actually delivered to the centers. In France⁸ the Government has established 15 radium centers in various parts of the country, and allocated to them 31.5 grams of radium (in addition to about 20 grams believed to be privately owned). In Sweden⁹ the use of radium is highly organized under Government auspices. A strong movement was started in 1929 to acquire a larger supply of radium in England, where a governmental committee recommended that 24 grams be acquired in addition to about 25 grams then available in the British Isles.

"The federal commission [in Germany] for the control of cancer summoned experts recently to discuss the question of the purchase and distribution of radio-active substances such as radium and mesothorium. As a re-

⁵Belgian Radium Industry. Canadian Min. Jour., June, 1932, pp. 255, 256.

⁶Goodwin, W. M., Mines Branch Radium Plant. Canadian Min. Jour., June, 1932, pp. 253-255.

⁷National Radium Trust and Radium Commission, First Ann. Rep., 1929-1930, London, 1930, 74 pages.

⁸See Ref. 2.

⁹See Ref. 2.

All of the reports did not designate the kind of salt in which the radium was held. Those reporting, however, gave the following quantities:

	Milligrams
Bromide	24,676.44
Sulphate	49,939.23
Chloride	17,047.11
Carbonate	169.01
Other	1,119.64

The quantity of radium in each form, as shown by the reports, is as follows:

	Milligrams
Applicators	4,186.60
Needles	42,369.63
Tubes	35,223.79
Solution	26,027.65

From the reports it is estimated that the number of patients treated annually with radium is approximately 80,000. Individuals, companies, and hospitals to the number of 710, owning 124.7 grams of radium, estimate that they need 117.4 grams more. It has been suggested that the amount needed might be estimated from the number of persons who could be benefited by radium treatment. As any statistics for such an estimate are limited, it seems best to consider only malignant newgrowths and to neglect the 25 or 30 other conditions which, at least in selected cases, are benefited by radium.

In 1900 when the registration area was first formed, the crude death rate from cancer was 63 per 100,000 population. In 1920 it was 83.4, and in 1929 (the latest available figures) it was 96.1, an increase over the crude death rate of 1900 of nearly 52.5 per cent. In 1929 the total number of deaths from cancer was 111,569. This makes cancer the second most important cause of death. Heart disease alone, with 245,000 deaths, claimed a greater number of victims. One of the most striking increases in the death rate has been in the so-called external forms of cancer, such as cancer of the breast

and cancer of the mouth, in which, because of the superficial position, errors in diagnosis are low as compared with the possibility for error in deep-seated cancer such as that of the stomach or other internal organs.¹² Hess, using these cancer mortality statistics as a basis, estimates that "at least ten times as much radium could be used advantageously as seems to be held in this country at present."

SUMMARY

Radium was first produced commercially from residues of uranium from the mines of Joachimsthal, Bohemia. Radium-producing ores have been found in about ten countries.

The United States Bureau of Mines devised methods of recovering radium which greatly reduced the cost. The plant operated by the Bureau of Mines from June, 1914, to January, 1917, produced about 8.5 grams of radium.

Up to 1926, 202.5 grams of radium have been produced in the United States; none has been produced since that date. Radium to the amount of 85.87 grams has been imported into the United States, chiefly since 1923.

It is estimated that 2 grams per year, or a total of 30 grams, have been used for luminous materials.

In about 83 per cent return on over 6,600 hospitals and clinics in the United States, 287 report having 85.8 grams of radium; 128 hospitals and clinics each have 75 milligrams or more; 414 physicians report having 33,286.93 milligrams, and 171 physicians each have 75 milligrams or more; 9 laboratories and companies report having 5,545.42 milligrams, 5 of which each have 75 milligrams or more. New York State reported 29,800.61 milligrams. No radium was reported from one State (Wyoming),

¹²These figures are quoted from *Health News*, issued by the U. S. Public Health Service on Oct. 13, 1931.

American Society for the Control of Cancer, which are recognized to be only relatively complete, the total amount of radium owned in quantities of 75 milligrams and over in the United States is 85,228 milligrams. The hospitals owning 75 milligrams and over number 135. The 135 hospitals own 68,033 milligrams. The individuals owning 75 milligrams and over total 47, with a total of 6,945 milligrams."

The United States Bureau of Mines recently sent out to all the hospitals listed in the 1931 Directory of the American Medical Association the following letter and questionnaire, A and B:

(A)

"The Bureau of Mines is asked repeatedly as to the need for additional radium in the United States. The question naturally arises as to how much is now available, the number of people receiving treatment, and the total number of treatments needed.

"In order to more accurately supply this information, the inclosed questionnaire is being sent to the principal hospitals in the United States. I would very much appreciate it if you would have this form filled out as completely as possible and returned at once in the inclosed franked envelope.

"Yours sincerely,

(Signed) R. R. SAYERS,
Chief Surgeon, U.S.B. of M;
Surgeon, U.S.P.H.S.

(B) RADIUM—FOR MEDICAL USE

"1. How much radium (element) have you on hand.....grams.....milligrams?

"2. Please show below quantity of radium in each salt:

Salt	Grams	Milligrams
Bromide
Sulphate
Chloride
Carbonate
Other (please specify)

"3. Date when acquired.....

"4. Please show below quantity of radium in each form:

Form	Grams	Milligrams
Applicators
Needles
Tubes
Solution

"5. Number of patients treated annually.....

"6. Total number of treatments.....

"7. If you do not have radium, how is radium treatment obtained for patients in your hospital or in your vicinity who need such treatment?.....

"8. What is the usual price paid per milligram-hour by your hospital or by individuals to institutions or persons furnishing radium treatment?.....

"9. Are these arrangements satisfactory to your institution?.....

"10. How much more radium could you use to advantage?.....

(This question is intended only to give the United States Bureau of Mines an idea of the country's need for more radium.)

"11. Do you know of physicians outside of hospitals having radium in your city? If so, please give names on reverse of this sheet.

(Please sign here)

(Official title)"

To date, 287 hospitals and clinics have reported that they have a total of 85,800.26 milligrams of radium, and 128 of the 287 each had 75 milligrams or more; 414 physicians have reported that they have 33,286.93 milligrams and 171 of the 414 each had 75 milligrams or more; nine laboratories and companies have reported that they have 5,545.42 milligrams and five of the nine each had 75 milligrams or more. New York, as would be expected, had the largest amount — 29,800.61 milligrams; Pennsylvania had the next largest amount—12,902.21 milligrams. Five States reported no radium in hospitals, and, according to the reports received, no radium is owned in one State (Wyoming).

2. Patients under 35 years of age, unless the condition is malignant.

3. Pedunculated fibroids.

4. Uterine tumors larger than a four-months' pregnancy, or those causing considerable pressure, when the patient is a satisfactory surgical risk.

5. Marked anemia.

Pelvic Infection.—When massive doses of x-rays or radium are used in the presence of an acute pelvic infection or inflammation, the lesion will become more active and the patient may be very sick.

Young Women.—It has long been the consensus of opinion that the menopause should not be induced by any means before the patient is 35 years of age, except for malignancy or some other very urgent cause.

Pedunculated Fibroids.—It is evident that, if the rays cause a disintegration of the tumor tissues, and if the tumor is on a pedicle, the latter will undergo disintegration long before the mass of the tumor. The necrosed tumor remains loose in the abdomen, necessitating a hurried laparotomy.

Very Large Tumors.—If the pelvis is tightly filled with a tumor, or one is present that is larger than a four-months' pregnancy, and the patient is a good surgical risk, surgery should be employed, rather than irradiation. If the patient is not a good surgical risk, good results may be obtained in most cases by irradiation.

Marked Anemia.—Patients in whom the red cell count is under 2,500,000 should not be subjected to massive doses of radium or x-rays. An effort should be made to bring up the red cell count, if anemia exists. If the anemia is due to severe uterine bleeding, small doses of radium should be used to control hemorrhage, then larger doses as the patient is able to stand them.

SOME COMMON CONDITIONS AMENABLE TO IRRADIATION

Leukorrhœa.—In most intractable non-

gonorrheal cases, cure may be expected within about six months.

Menorrhagia and Metrorrhagia.—Irradiation of from 300 to 800 mg.-hrs. in the fundus will usually correct these conditions. Hypertrophic endometritis and so-called idiopathic bleeding may be corrected with approximately the same dosage.

Excessive Menstruation in Consumptives.—As a rule Nature takes care of these cases by stopping menstruation or making it scanty; however, there are some patients who bleed excessively at menstruation, with resultant weakening. In my opinion the menstruation should be suppressed by irradiation at least until the patient has become an arrested case.

Uterine Polypi.—The cervix should be dilated, the polypi removed, and from 500 to 800 mg.-hrs. of radium applied in the fundus. If the patient is past 35 years of age, it is probably best to give as much as 2,500 milligram-hours.

Large, Boggy Retroflexions.—If the patient is near the menopause and the condition is causing marked symptoms, relief may be given in a few months by the use of large doses of radium.

Uterine Tumors (Non-malignant).—Patients past 35 years of age should be given large doses of radium, if the tumor is causing symptoms and there are no contra-indications. If irradiation is contra-indicated, resort to surgery should be had. Irradiation is preferable to surgery in these cases because the pain is many times less, the cost is less, the convalescence is markedly shortened, and the end-result is more satisfactory. Surgery in these cases is at least twelve times more dangerous to the patient than irradiation.

Cancer of the Cervix.—It seems that the most doubting surgeons have at last been convinced that, in cancer of the cervix, surgery should practically never be resorted to.

and no radium was reported in hospitals from 5 States. Seven hundred and ten individuals, companies, and hospitals, owning 124.7 grams of radium, estimate that

they need 117.4 grams more. From the reports, it is estimated that approximately 80,000 patients are treated annually with radium.

INDICATIONS FOR IRRADIATION IN INTRA-UTERINE BLEEDING¹

By JOHN H. VAUGHAN, M.D., AMARILLO, TEXAS

IT is safe to say that, when a case of uterine bleeding presents itself, a large percentage of our physicians give medicines, without an intensive examination, in the hope that the bleeding will stop. If it does not, the patient is subjected to the inconvenience, pain, and expense of a dilatation of the cervix and curettement of the uterus. This may correct the condition. If it does not, the patient is advised that a hysterectomy must be done, and, in a great percentage of cases, she accedes rather than to continue bleeding.

Radiologists, knowing the advantage of irradiation over surgery in most of these cases, should continue to talk about it so that the average physician will not condemn his patients to surgery, with unnecessary suffering, extra expense, prolonged convalescence, unsatisfactory end-results, and even death. Every honest physician and surgeon is interested enough in his patients to want them to have what is best. Radiology is not old enough for its indications to be well understood by physicians who have not had sufficient contact with cases treated by irradiation to observe the results.

Radiology certainly should be considered an adjunct to surgery, and not a competitor. In my opinion, a man who has done considerable surgery of the pelvis should be more capable of stating the indications for, and application of, radium there. However,

he should not consider himself capable of applying radium just because he is a surgeon. Neither should he attempt to treat cases amenable to irradiation through the instructions of some concern which rents out radium and gives as a bonus the instructions in the case. It would be as reasonable for a druggist to try to treat a case of pneumonia through the instructions of a physician at some remote point.

One of the most common causes of radium being brought into disrepute is the mistakes made by men untrained in radiology. If a physician is going to apply either radium or x-rays as a therapeutic measure, he should associate himself long enough with men of experience in this field to acquaint himself with the indications, reactions, and results of the rays. If he has no intention of applying the science of radiology himself, it behooves him at least to read enough along this line to have a well based idea of when to refer his patients to a radiologist, just as the internist must know when to refer his patients to a surgeon, or *vice versa*.

We are not mentioning in this paper the medical or surgical measures in uterine bleeding but are only trying to point out some of the more common conditions in which irradiation is indicated.

Some of the contra-indications for the use of large doses of radium and x-rays in pelvic cases, otherwise amenable to treatment by irradiation, are:

1. Acute pelvic infection.

¹Read by title at the Seventeenth Annual Meeting of the Radiological Society of North America, at St. Louis, Nov. 30-Dec. 4, 1931.

EDITORIAL

LEON J. MENVILLE, M.D. Editor
BUNDY ALLEN, M.D. Associate Editor

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THE EFFECT OF THE DEPRESSION ON RADIOLOGY

The depression has been the occasion for many members of the medical profession to lose a keen sense of justice in their relations with their fellow-practitioners. Some have suffered from an obsession of fear that they are in danger of losing all their practice, with an accompanying financial loss, and that great harm was about to befall them. For this reason they became the worst pessimists of all. There could not be an optimistic future—all was hopeless! They became desperate and fearless. Many new combination cut-throat practices emanated from their disturbed minds. No amount of persuasion could make them see the light of wisdom and fair play.

Then, again, we have others, somewhat more optimistic, who admitted they could get along comfortably if only they were permitted to dictate the policies and practices of members of the medical profession—practices which would redound in financial benefits to themselves.

It is with pride we can say that the larger number of our noble profession have remained sane. They have taken their misfortunes with a smile, trusting that conditions will improve, ready and willing to cooperate with organized medicine for the best interests of all. Much praise is due these noble men who have remained untainted, unselfish, loyal American physicians.

In the very early beginning of the depression the medical profession was assailed for the high cost of medical care. After a cer-

tain amount of discussion and deliberation by a few, it was thought best to attack the financial policies of hospitals, and in a measure rightly so. It was generally agreed that if certain hospitals would separate themselves from their pet hobby, free clinics, they would then be able to run along satisfactorily and be able to reduce their overhead enough to offer some reduction in their rates. It was thought that this would perhaps prove satisfactory if put into operation. But the operating executives soon became apprehensive that this would not be sufficient to appease the dissatisfied ones, and began to search for some new way of "passing the buck." Ever since then we have heard talk of reducing the cost of laboratory work, and recently some have advocated reduction in the number of roentgen examinations in order to reduce the "high cost of medical care."

There has just appeared in a prominent medical bulletin an article written by an eminent American surgeon in regard to important matters concerned with the practice of medicine. In this article the author says that "during the last few months we have all learned that many of the mechanical tests can be dispensed with and that they need not be repeated. Fewer roentgen examinations are required. The depression may be beneficial, as far as medical practice is concerned, in re-establishing sound medical practice and emphasizing the value of the general practitioner."

It would seem that roentgenology is thought to be a nice football to kick around, and to have placed upon it the responsibility for the high cost of medical care. Why single it out for curtailment from among other so-called "mechanical tests"? Are we to believe that pathologic examinations

Adenocarcinoma is the most radioresistant of the cancers, but even in it surgery does not seem so efficient as radium. In early cervical cancer, the uterine, cervical, and vaginal canals are the only areas in which the radiating substance is placed. However, if the cancer has metastasized, external radium or x-rays should be used.

Cancer of the Fundus.—Until recently surgeons and radiologists considered that a fundal cancer was best treated by combining radium and surgery. It seems that statistics are about to prove that it is best not

to perform any surgery, even in these cases, but to depend on irradiation.

As stated by Dr. J. C. Bloodgood, if there is a question of doubt, it is both theoretically and practically wiser to try irradiation first in most cases. Remember, however, that there are a few cases in which delayed surgery might be harmful.

We have not given statistics in this paper nor are we saying much about the technic of treatment. Many convincing statistics are available from our large clinics and hospitals.

BOOK REVIEW

LE RÉMANIEMENT NOSOLOGIQUE DE LA DILATATION DES BRONCHES PAR L'APPLICATION SYSTÉMATIQUE DU LIPIODO-DIAGNOSTIC (The New Classification of Bronchial Dilatations by the Systematic Application of Lipiodol Diagnosis). By POUMEAU-DELILLE. Preface by PROFESSOR EMILE SERGENT. Pages 132, with 27 illustrations. Masson et Cie., Editeurs, Paris, 1932. Price, 24 francs.

The use of lipiodol in diagnosis permits the recognition of the unexpected frequency of bronchial dilatations by showing up the characteristic images in the cases of non-fetid bronchorrhea. On the other hand, this method of study renders possible the differentiation of the pseudo-vomicæ of bronchial dilatations from the true vomicæ due to a pulmonary supuration.

The simple radiologic appearance, that is, without the aid of lipiodol, in cases of bronchiectasia is generally not highly characteristic, consisting of a more or less generalized or localized accentuation of the descending shadows of the lung tree. Sometimes the shadow of a retractile pleuropulmonary sclerosis suggestive of mediastinal pleurisy attracts attention and suggests the possibility of a bronchiectasis, to be confirmed by the use

of lipiodol. After the injection of iodized oil the shadows of beaded, ampullar, sac-like dilations are characteristic of bronchiectasis. Certain shadows of displaced bronchi with puddling of lipiodol do not necessarily indicate the presence of bronchial dilatations; for instance, they may be due to pulmonary sclerosis with emphysema.

It is possible to recognize the radiologic aspects of bronchiectasis on the simple films by comparing films made before and after the injection of lipiodol; the dilated bronchi as a rule appear in the form of dark areas, while the clear adjacent areas suggesting cavities correspond to the healthy pulmonary parenchyma.

The foregoing are some of the conclusions drawn by the author from his work, which was done under the supervision of Professor Sergent. They crystallize the results of the last ten years in the clinic of the well-known investigator of pleuro-pulmonary roentgenology in his research on the application of the method of Sicard and Forestier to pulmonary disorders. This excellent little work is beautifully illustrated, much better than the average French publication. The text is amplified by an excellent bibliography and by detailed observations on 48 cases.

EDITORIAL

LEON J. MENVILLE, M.D. *Editor*
BUNDY ALLEN, M.D. *Associate Editor*

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In the very early beginning of the depression the medical profession was assailed for the high cost of medical care. After a cer-

tain amount of discussion and deliberation by a few, it was thought best to attack the financial policies of hospitals, and in a measure rightly so. It was generally agreed that if certain hospitals would separate themselves from their pet hobby, free clinics, they would then be able to run along satisfactorily and be able to reduce their overhead enough to offer some reduction in their rates. It was thought that this would perhaps prove satisfactory if put into operation. But the operating executives soon became apprehensive that this would not be sufficient to appease the dissatisfied ones, and began to search for some new way of "passing the buck." Ever since then we have heard talk of reducing the cost of laboratory work, and recently some have advocated reduction in the number of roentgen examinations in order to reduce the "high cost of medical care."

There has just appeared in a prominent medical bulletin an article written by an eminent American surgeon in regard to important matters concerned with the practice of medicine. In this article the author says that "during the last few months we have all learned that many of the mechanical tests can be dispensed with and that they need not be repeated. Fewer roentgen examinations are required. The depression may be beneficial, as far as medical practice is concerned, in re-establishing sound medical practice and emphasizing the value of the general practitioner."

It would seem that roentgenology is thought to be a nice football to kick around, and to have placed upon it the responsibility for the high cost of medical care. Why single it out for curtailment from among other so-called "mechanical tests"? Are we to believe that pathologic examinations

should also be restricted? Are bacteriologic examinations to be limited? All these and others come under the so-called "mechanical tests." The writer of the article referred to would have us infer that it took the depression to show us how many roentgen examinations have been made unnecessarily and that, perhaps, with their curtailment, the general practitioner might expect to reap financial benefits. But internists and surgeons are none too ready to undertake major procedures without the guidance of the preliminary x-ray examinations upon which they have learned to depend. Nor is it altogether certain that this form of economy will appeal to intelligent patients, and it is rather a pity to deprive the ignorant ones of the advantages of modern medical procedures.

From the article it would appear that the author has in mind to diminish the already insufficient amount of laboratory teaching, for he says: "The laboratory has been over-emphasized, and the medical student, instead of arriving at a fairly accurate diagnosis through history-taking and physical examination, has resorted to many early and oft-repeated laboratory tests or mechanical procedures." To restrict or abolish the teaching of these so-called mechanical tests would be the cause for the progress of medicine to come to a standstill, and our medical students would have to learn the stunts of the doctor of long ago, when the practice of medicine was very much the practice of diplomacy. If medical students are to be restricted in or deprived of the knowledge of the uses of such indispensable diagnostic measures as pathologic and bacteriologic examinations and roentgen-ray examinations, we might as well begin to teach them the stunts of the good old doctors of the good old days. Those were the days, we are told, of prosperity, and also the days when the good old doctor would look at your tongue, feel your pulse, ask about the folks, and how they were going to vote in the coming elections, also how the mustard seed was coming on

which was planted in the last quarter of the moon. He would then slap you kindly on the back, and tell you that your ailment was liver trouble (when it might have been pulmonary tuberculosis). After writing four or five prescriptions, among which was one for some patented Liver Regulator, he would ask you for a dollar, the price of his examination. We will admit that one dollar for a medical examination is within the reach of nearly every one, but who would prefer such an examination?

Would we be satisfied to do away with diagnostic agencies at this time and resort to the old-time custom of exploratory operations? This often proves a lucrative practice, *subjecting the patient to hospital and operative expenses*. If this is economy, it can only be depraved economy.

We all agree that in times such as these, members of the medical profession should consider the economic conditions of their patients. Certainly the radiologists have done their part. They have made their prices conform to the patients' ability to pay, and, besides, they have had to meet the competition with certain physicians who send their patients to be x-rayed by charity institutions while they themselves continue treating them as private patients.

Inasmuch as roentgen-ray examinations have been thought to play an important part in the high cost of medical care, would it not be interesting if organized medicine could obtain statistics on the cost and charges for all types of medical examinations and operations of all specialties of medicine? There can be no question as to what such statistics would show. In the instance of roentgenology, the costly apparatus and operating expenses raise the overhead tremendously, while the roentgenologist's charges, when compared to his costs, are moderate.

In the instance of the various surgical specialties, it would be found that the cost is small and the charge high. It has been

known to happen that x-ray examination renders an exploratory operation unnecessary, in which case the patient can well afford to pay \$25 or \$50 to save several hundred, to say nothing of his anxiety and suffering.

This is no time for suggestions regarding changes in practices which have been found indispensable in medical care. What we need is co-operation between all who practise medicine and minister to the sick, setting aside all "small petty differences and jealousy." Let it be a give-and-take proposition.

Is it not generally admitted by the unprejudiced that modern methods of precision as embodied in laboratory and radiation methods have proved of value? If any have unnecessarily subjected their patients to tests, because such were available and, in the abstract, desirable, let them exercise moderation. But surgeons and clinicians and dentists are the last individuals who ought to advise patients to do away with essential tests. To do so is to lose the ground which modern medicine has already gained.

ANNOUNCEMENTS

RADIOLOGY HONORED

When radiology received its first honor it was considered as news; now that it has been honored so many times, particularly by the American Medical Association, the National Board of Medical Examiners and others, it may be no longer considered news by some. However, we are certain that our readers will agree with us that radiology has been honored once more when one of its members has been appointed to represent radiology in America. We have just received news from Washington that Edwin C. Ernst, M.D., past president of the Radiological Society of North America, past president of the American Radium Society, to speak of only two posts of honor he has

held, has been appointed as a Permanent Trustee of the National Health Foundation, of Washington, D. C.

The National Health Foundation has made a wise selection in Dr. Ernst. They will find in him an energetic and dependable, and most capable, worker.

AMERICAN REGISTRY OF RADIOLOGICAL TECHNICIANS

H. B. Podlasky, M.D., Chairman of the American Registry of Radiological Technicians, desires to notify the radiologists of North America that the Registry is now in a position to begin the classification of approved x-ray departments for instruction in x-ray technic.

Radiologists who desire to have their courses approved are requested to send a letter of inquiry to E. A. Pohle, M.D., Ph.D., Department of Radiology, University of Wisconsin, Madison, Wisconsin.

INDIANA ROENTGEN SOCIETY

The sixth annual meeting of the Indiana Roentgen Society was held in Indianapolis on February 22. E. R. Witwer, M.D., of Detroit, addressed the Society.

The following officers were elected: *President-elect*, W. R. Cleveland, M.D., of Evansville; *Vice-president*, H. H. Inlow, M.D., of Shelbyville; *Secretary-Treasurer*, James N. Collins, M.D., of Indianapolis.

FOURTH CONGRESS, PAN-AMERICAN MEDICAL ASSOCIATION

DALLAS, TEXAS, MARCH 21-25, 1933

The Congress which has just closed is the fourth in the series this Association has successfully conducted, the first in Havana, the second in Panama, and the third in Mexico City.

In the Section on Radiology the speakers

were Albert Soiland, M.D. (Radiologic Concept of Treatment of Cancer of Breast); W. W. Watkins, M.D. (Treatment of Lung Cavities); David Escalante, M.D. (Electrotherapy in Tuberculosis); Pedro L. Farinas, M.D., and M. Mitrani, M.D. (paper in Spanish language), and Victor Randolph, M.D. (X-ray Demonstrations of Cavity Closure by Surgical Methods). Each paper was followed by discussion.

The attendance was considered excellent, and there is no question but that those who came to the Congress and participated found it well worth while.

PRELIMINARY PROGRAM OF THE AMERICAN CONGRESS OF RADIOLOGY¹

SEPTEMBER 25 TO 30, 1933, INCLUSIVE

Monday, 9:00 A.M., September 25, 1933

Address of Welcome by President of the Chicago Medical Society, Austin A. Hayden, M.D.

Address by the President of the Exposition, "A Century of Progress," President Rufus C. Dawes

Address by the Surgeon-General of Public Health of U. S., Surgeon-General Hugh S. Cumming

Address by the Editor of the *Journal of the American Medical Association*, Morris Fishbein, M.D.

Intermission—15 Minutes

Address by the President of the American Congress of Radiology, Henry K. Pancoast, M.D.

Address by Franklin H. Martin, M.D., Executive Director of American College of Surgeons

Address, "Radiosensitivity of Tumor Tissue," James Ewing, M.D.

Brief report of committees—special announcements

¹This program is almost complete. It replaces the scientific programs of the American Radium Society, the American Roentgen Ray Society, the Radiological Society of North America, also the Annual Meeting of the American College of Radiology.

(Note.—Following the opening meeting, the special committee meetings of the various component radiological societies will be announced by the officers of the societies, and may take place some time after adjournment each day.)

2:00 P.M.—Adjournment

Tuesday, 9:00 A.M., September 26, 1933

*Section "A," General Group of Papers
Devoted to Chest Diseases*

H. KENNON DUNHAM, M.D., Cincinnati, Ohio

"The Roentgen Ray in the Study of Pathology of Pulmonary Tuberculosis."

LAWRASON BROWN, M.D., and MR. HOMER L. SAMPSON, Saranac Lake, N. Y.

"Correlation of Clinical and Roentgenological Observation in Pulmonary Tuberculosis."

F. MAURICE MCPHEDRAN, M.D., Philadelphia, Pa.

"Tuberculosis in Children."

FRED JENNER HODGES, M.D., and C. B. PEIRCE, M.D., Ann Arbor, Mich.

"The Roentgen Examination of the Heart; A Critical Study of the Frontal Silhouette."

WILLIS F. MANGES, M.D., Philadelphia, Pa.

"An Analysis of a Group of Primary Carcinomas of the Lungs, Treated with Deep X-ray Therapy."

WILLIAM H. STEWART, M.D., and H. EARL ILLICK, M.D. (by invitation)

"Where is the Diaphragm?"

11:00 A.M.—Recess

GEORGE W. HOLMES, M.D., Boston, Mass.
"Lymphoblastoma of the Chest and Elsewhere."

CHARLES A. WATERS, M.D., Baltimore, Md.

"Roentgen Diagnosis of Interlobar Pleurisy" (lantern slides)

W. WALTER WASSON, M.D., Denver, Colo.
"Accessory Sinus Diseases in Relation to Chest Diseases."

W. WARNER WATKINS, M.D., Phoenix, Ariz.

"Non-tuberculous Inflammation of the Lungs."

WILLIAM A. EVANS, M.D., Detroit, Mich.
 "Surgical Conditions within the Chest,
 under Roentgen Observations."

LEROY SANTE, M.D., St. Louis, Mo.

"The Radiological Detection of Obscure
 Foci of Suppuration in the Chest."

MR. REX WILSEY, Physics Dept., Research
 Lab., Eastman Kodak Co., Rochester,
 N. Y.

"Scattered X-rays in Chest Roentgen-
 ography."

2:00 P.M.—Adjournment

Wednesday, 9:00 A.M., September 27, 1933

Section "A," Gastro-intestinal Diseases

B. R. KIRKLIN, M.D., Rochester, Minn.

"Duodenitis and its Roentgenologic
 Characteristics."

LEWIS GREGORY COLE, M.D., New York
 City

"Application of Roentgenological Find-
 ings to the Solution of Gastro-intestinal
 Problems."

JAMES T. CASE, M.D., Chicago, Ill.

"Functional Disturbances of the Colon in
 Relation to the Roentgen Diagnosis of
 Organic Colonic Disease."

EUGENE P. PENDERGRASS, M.D., and W.
 OSLER ABBOTT, M.D., Philadelphia, Pa.

"An Evaluation of a New Procedure in
 the Study of the Small Intestine."

JOHN L. KANTOR, M.D., and SAMUEL
 SCHECHTER, M.D., New York City

"Colon Studies. VII.—Variations in the
 Fixation of the Cecocolon: Their Clinical
 Significance."

R. R. NEWELL, M.D., San Francisco, Calif.

"Statistical Work on Visualization of the
 Gall Bladder by the Oral Method."

SHERWOOD MOORE, M.D., and EVARTS A.
 GRAHAM, M.D., St. Louis, Mo.

"Explanation of the Errors in Diagnosis
 of Gall-bladder Disease."

11:00 A.M.—Recess

HOLLIS E. POTTER, M.D., Chicago, Ill.

"Roentgenology of Duodenal Ulcer: (a)
 Behavior of the Stomach and Duodenum;

(b) Methods of Obtaining Outline De-
 formity in Roentgenograms."

J. J. VALLERINO, M.D., Panama, R. P.

"Roentgenologic Studies of Amoebic
 Colitis."

NELSON M. PERCY, M.D., and DAVID S.
 BEILIN, M.D., Chicago, Ill.

"Analysis of 1,000 Consecutive Exami-
 nations of the Stomach and Duodenum
 from the Clinical, Roentgenological, and
 Surgical Viewpoints, with Particular Ref-
 erence to the Incidence, Diagnosis, and
 Treatment of Ulcer and Carcinoma of the
 Stomach."

E. T. LEDDY, M.D., Rochester, Minn.

"Dangers of Fluoroscopy and Methods of
 Protection."

2:00 P.M.—Adjournment

Thursday, 9:00 A.M., September 28, 1933

*Section "A," Diseases of Bones and Joints;
 Bone Tumors*

CHARLES F. GESCHICKTER, M.D., Balti-
 more, Md.

"Seventy Cases of Five-year Cures in
 Sarcoma of Bone" (lantern slides).

HOWARD P. DOUB, M.D., Detroit, Mich.

"Injuries of the Spine, Both Acute and
 Chronic."

LAWRENCE REYNOLDS, M.D., and E. R.
 WITWER, M.D., Detroit, Mich.

"Parathyroid Disease."

WILLIAM B. COLEY, M.D., and BRADLEY
 L. COLEY, M.D., New York City

"The Treatment of Giant-cell Tumors of
 Long Bones."

11:00 A.M.—Recess

RALPH S. BROMER, M.D., E. P. CORSON-
 WHITE, M.D., and IRVING STINE, M.D.,
 Philadelphia, Pa.

"Osteomalacic Diseases in Monkeys: A
 Metabolic and Roentgenographic Study."

D. B. PHEMISTER, M.D., Chicago, Ill.

"X-ray Evidences of Necrosis of the
 Head of the Femur Following Intra-
 capsular Fractures of the Neck."

RAY A. CARTER, M.D., Los Angeles, Calif.

"Infectious Granulomas of the Bones and Joints, with Special Reference to Coccioid Disease."

E. C. VOGT, M.D., and C. F. MCKHANN, M.D., Boston, Mass.

"Lead Poisoning in Infants and Children."

L. G. MCCUTCHEN, M.D., St. Louis, Mo.
Moving Picture—"Reduction of Fractures and Removal of Foreign Bodies under Fluoroscopic Control, Using Oil-immersed Units and Special Fracture Device."

L. A. MILKMAN, M.D., Scranton, Pa.

"Further Observations on Spontaneous Multiple Symmetrical Fractures."

2:00 P.M.—Adjournment

Friday, 9:00 A.M., September 29, 1933

Section "A," Urology and Gynecology

LEOPOLD JACIIES, M.D., and MOSES SWICK, M.D., New York City

"Studies with Opaque Media in Urology."

DON CARLOS HEUSER, M.D., Buenos Aires, Argentina

"Opaque Studies of the Uterus and Pelvis."

HANS A. JARRE, M.D., Detroit, Mich.

"Renal Peristalsis during Pyelonephritis: A Roentgen-physiologic Study."

BERNARD H. NICHOLS, M.D., Cleveland, Ohio

"Further Observations in the Diagnosis of Tumors of the Kidney."

11:00 A.M.—Recess

ERNST A. POHLE, M.D., Ph.D., Madison, Wis.

"The Fate of Thorium Dioxide in the Body after Intravenous Injection."

LEON SOLIS-COHEN, M.D., and SAMUEL BRUCK, M.D., Philadelphia, Pa.

"Roentgen Examination of the Chests of 500 Newborn with Reference to Pathology Present Other Than Enlarged Thymus."

2:00 P.M.—Adjournment

Saturday, 9:00 A.M., September 30, 1933
Section "A," Neurology and Miscellaneous

MERRILL C. SOSMAN, M.D., Boston, Mass.

"Pituitary Tumors; Radiological Aspects of Diagnosis and Treatment."

KARL KORNBLUM, M.D., and FRANCIS C. GRANT, M.D., Philadelphia, Pa.

"Encephalography."

JOHN D. CAMP, M.D., Rochester, Minn.

"Spinal Cord Lesions and Their Recognition by Roentgenologic Methods."

A. HOWARD PIRIE, M.D., Montreal, Quebec, Can.

"Visualization of the Cerebro-spinal Fluid System by Air or Oxygen."

EDWIN C. ERNST, M.D., St. Louis, Mo.

"Roentgenological Considerations of Sinus Diagnosis with and without Radiopaque Oils."

11:00 A.M.—Recess

AMÉDÉE GRANGER, M.D., New Orleans, La.

"The Diagnosis of Accessory Sinuses."

FREDERICK M. LAW, M.D., New York City

"Diagnosis of Mastoid Disease."

2:00 P.M.—Adjournment

A. W. CRANE, M.D., Kalamazoo, Mich.

"The Genealogy of the X-ray."

SEELEY G. MUDD, M.D., Pasadena, Calif.

Title to be announced.

DR. W. D. COOLIDGE and DR. E. E. CHARLTON, Schenectady, N. Y.

"Some Practical Applications of the Recent Advances in Physics."

DR. CHARLES C. LAURITSEN, Pasadena, Calif.

"The Solution of Some Problems in High Voltage Equipment."

DR. LAURISTON S. TAYLOR, Washington, D. C.

"Application of Physical Measurements in Clinical Irradiation."

G. FAILLA, D.Sc., New York City

"Physical and Biological Characteristics of 700 K.V. X-ray."

E. H. QUIMBY, M.A., and M. M. COPELAND, M.D., New York City

"Distribution of X-rays within the Human Body."

G. FAILLA, D.Sc., and L. MARINELLI, B.Sc., New York City

"The Measurement of Gamma Rays in Roentgens."

FLOYD F. CRAVER, M.D., and WILLIAM S. MACCOMB, M.D., New York City

"Heublein's Method of Continuous Irradiation of the Entire Body in the Treatment of Generalized Neoplasms."

T. LEUCUTIA, M.D., Detroit, Mich.

"The Problems of Protection and Their Solution in Short Wave Therapy."

PAUL C. HODGES, M.D., Chicago, Ill.

"The Place of Roentgenology in the University: A Program of Teaching and Investigation."

A. MUTSCHELLER, Ph.D., Westinghouse X-ray Corp., Long Island City, N. Y.

"Studies on Composite X-ray Filters."

Wednesday, 9:00 A.M., September 27, 1933
Section "B," Breast Diseases

IRA H. LOCKWOOD, M.D., Kansas City, Mo.
"Further Observations in Roentgen Diagnosis of the Breast."

ALBERT SOILAND, M.D., Los Angeles, Calif.
"Combined Surface and Interstitial Radiation in the Treatment of Mammary Cancer."

BURTON J. LEE, M.D., New York City
"Irradiation Results in the Treatment of Cancer of the Breast."

ERNST A. MAY, M.D., Newark, N. J.
"Distribution of X-ray Intensity in Tissue with the Central Ray Striking the Surface, at Angles other than 90 Degrees."

11:00 A.M.—Recess

GEORGE E. PFAHLER, M.D., and JACOB H. VASTINE, M.D., Philadelphia, Pa.
"Technic and Results of Irradiation in Carcinoma of the Breast."

GORDON E. RICHARDS, M.D., Toronto, Ont., Canada

"The Treatment of Chest Wall Secondaries in Breast Carcinoma: A Preliminary Report of a New Technic."

A. U. DESJARDINS, M.D., Rochester, Minn.

"A Classification of Tumors from the Standpoint of Radiosensitiveness."

ALEXANDER BRUNSCHWIG, M.D., Chicago, Ill.

"Histopathology of Irradiated Hodgkin's Disease and Lymphoblastoma."

2:00 P.M.—Adjournment

Thursday, 9:00 A.M., September 28, 1933
Section "B," Cancer of the Mouth, Skin; Miscellaneous

CHARLES L. MARTIN, M.D., Dallas, Texas
"Irradiation Treatment of Cancer of the Lip and Mouth; Technic and Results"

DOUGLAS QUICK, M.D., New York City
"Management of Cancer of the Mouth and the Cervical Lymphatics."

HAYES E. MARTIN, M.D., and ROBERT E. McNATTIN, M.D., New York City

"The Treatment of Carcinoma of the Pharynx, Tonsil, and Extrinsic Larynx by Divided Doses of Roentgen Therapy."

GEORGE W. GRIER, M.D., Pittsburgh, Pa.

"Cancer of the Skin."

JOSEPH JORDAN ELLER, M.D., New York City

"Results of Irradiation in Diseases of the Skin."

MAURICE LENZ, M.D., CORNELIUS COAKLEY, M.D., and A. P. STOUT, M.D., New York City

"Roentgentherapy of Epitheliomas of the Pharynx and Larynx."

11:00 A.M.—Recess

LEO E. PARISEAU, M.D., Montreal, Quebec, Can.

"The General and Medical History of Electricity Told with Old Books Taken from my Library."

J. ERNEST GENDREAU, M.D., Montreal, Quebec, Can.

"Three Years of 300 K.V. Cancer Therapy."

IRA I. KAPLAN, M.D., MILTON FRIEDMAN, M.D., RIEVA ROSH, M.D., and CARL B. BRAESTRUP, B.S.C., P.E., New York City
"Protracted Irradiation in the Treatment of Neoplasms of the Mouth and Pharynx: A Comparison between X-rays (Coutard Technic), 5-gram Radium Pack, and Small Radium Pack."

BERNARD P. WIDMANN, M.D., Philadelphia
"The Roentgen-ray and Radium Treatment of Cancer of the Lip."

FRANK E. SIMPSON, M.D., Chicago, Ill.
"Radium Treatment."

2:00 P.M.—Adjournment

Friday, 9:00 A.M., September 29, 1933
Section "B," Urology and Gynecology, and Abdominal Disease

BENJAMIN S. BARRINGER, M.D., New York City
"The Irradiation Treatment of Carcinoma of the Bladder."

WILLIAM P. HEALY, M.D., New York City
"Radiation Treatment of Carcinoma of the Cervix."

HENRY L. SCHMITZ, M.D., Chicago, Ill.
"Irradiation Treatment of Carcinoma of the Uterus."

LEDA J. STACY, M.D., Rochester, Minn.
"Benign Diseases of the Uterus."

RUSSELL H. FERGUSON, M.D., New York City
"Studies in the Diagnosis and Treatment of Teratoma Testis."

11:00 A.M.—Recess

F. LIBERSON, M.D., Stapleton, N. Y.
"The Multi-perforated Lead Screen in Deep Therapy."

H. H. BOWING, M.D., Rochester, Minn.

"Radium Treatment of Primary Carcinoma of the Rectum."

EDWARD L. JENKINSON, M.D., and A. R.

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2:00 P.M.—Adjournment

Saturday, 9:00 A.M., September 30, 1933

Section "B," Miscellaneous

LEON J. MENVILLE, M.D., New Orleans.

"Visualized Lymphatics."

WILLIAM EDWARD CHAMBERLAIN, M.D., Philadelphia, Pa.

"Pernicious Leukopenia."

EDWIN A. MERRITT, M.D., and EDGAR M. MCPHEAK, M.D., Washington, D. C.

"Diagnosis and Treatment of Parathyroid Dysfunction."

ROLAND E. LOUCKS, M.D., Detroit, Mich.

"Radium in the Treatment of Hyperthyroidism."

THOMAS A. GROOVER, M.D., and A. C. CHRISTIE, M.D., Washington, D. C.

"X-ray Treatment of Hyperthyroidism."

11:00 A.M.—Recess

U. V. PORTMANN, M.D., Cleveland, Ohio
"The Malignant Diseases of the Thyroid Gland."

JOHN M. KEICHLINE, M.D., Huntingdon, Pa.

"A Report of 62 Cases of Herpes Zoster Treated with X-rays."

BERNARD F. SCHREINER, M.D., Buffalo, N. Y., and WILLIAM H. WEHR, M.D., Buffalo, N. Y.

"Primary Newgrowths Involving the Hand."

WILLIAM H. CAMERON, M.D., New York City

"Training for Radium Therapy."

PEDRO L. FARINAS, M.D., Havana, Cuba
Title to be announced later.

2:00 P.M.—Adjournment

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H P Doub, M D	Ernst A Pohle, M D, Ph D
J E Habbe, M D	C G Sutherland, M D
A L Hart, M D	

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2:00 P.M.—Adjournment

long as the vomited or aspirated contents have a blue color. These measures on the part of the author have prevented the repetition of the experience in his practice.

L. J. CARTER, M.D.

THE ESOPHAGUS (DIAGNOSIS)

A Contribution to the Formation of Diverticula in the Lower Esophagus. Karl Nemec. *Röntgenpraxis*, April, 1932, IV, 304-309.

Diverticula in the lower portion of the esophagus are comparatively rare and usually small. Hiatus hernias may simulate large diverticula. The shape of the stomach is of great importance in differentiating the two, but greater yet is the appearance of the mucosa in the questionable sac, which shows gastric mucosa in a hernia and esophageal in a diverticulum. In diverticula one may find remnants of barium even after some days, a fact which is unlikely in diaphragmatic hernias. A case with a very large diverticulum in the lower third of the esophagus is described.

H. W. HEFKE, M.D.

DOSAGE

Ionization Measurements on the Influence of Secondary Beta Rays in Gamma-ray Therapy. E. Stahel. *Strahlentherapie*, 1932, XLIV, 575-584.

The intensity and penetrability of secondary radiation of various metal filters were studied. It appeared that the differences in intensity are insignificant and that the penetrability of secondary beta rays is small. There is, however, a characteristic difference between high atomic metals and those of medium atomic weight. For practical purposes it seems that the secondary filtration is insignificant in the case of transcutaneous treatment. In intratumoral irradiation the use of secondary filters of medium atomic weight permits of a more efficient exposure. Celluloid, aluminum, copper, gold, lead, and platinum were used in the investigation. As non-toxic metals for the secondary filters, silver, nickel, and chromium may be considered.

ERNST A. POHLE, M.D., Ph.D.

EXPERIMENTAL STUDIES

The Effect of Roentgen Rays on the Function of Secretory Organs. Observations on the Living Organ in Luminescent Light. I.—The Liver. W. Hartoch and M. Israelski. *Strahlentherapie*, 1932, XLIV, 557-574.

The authors exposed 100 frogs to roentgen rays. The technic was as follows: 180 K.V., 5 ma., 10 mm. Al or 0.5 mm. Cu, from 30 to 35 cm. F.S.D.,

dose from 10 to 4,000 r in one sitting given over the entire body or over the liver region only. The animals were paralyzed by curare. From 1.2 to 1.5 c.c. of uranin, injected subcutaneously, stained the liver and the serum a light green color. Thirty untreated frogs served as controls.

It appeared that there was no difference between the effects of the total body exposure and the exposure of the liver region alone. Some frogs lived up to 35 days after the total body exposure to high doses, while warm-blooded animals died within a few days after being exposed to only a small fraction of the dose. Comparing the irradiated and non-irradiated animals, it appeared that the excretion of the dye in the liver was definitely delayed in the first group. The methods of intravital microscopy in luminescent light were used in this investigation. The delay in excretion, following doses of 500 r and more, manifests itself five hours following exposure and lasts at least three weeks. The injury to the liver was augmented with increasing dosage. Intravital microscopy is recommended as an excellent method for the study of the function of secretory organs.

ERNST A. POHLE, M.D., Ph.D.

The Effect of Roentgen Rays on the Capacity of Rat Tumors to Absorb Iodine and Bismuth. Gösta Jansson. *Acta Radiologica*, 1932, XIII, Fasc. 5, pp. 533-550.

From experimental work the author concludes that small doses of x-rays have no effect on the ability of rat tumors to absorb iodine. If one uses somewhat larger doses of radiation, the absorbing power for iodine is reduced regardless of whether the filtration is heavy or not. This effect does not appear during the first twenty-four hours, but only after a few days.

The effect upon the absorption of bismuth by these tumors is exactly the opposite, absorption being increased as a result of irradiation.

A. L. HART, M.D.

Some Histologic Studies of the Action of Radium Alone and Combined with Freezing on the Neuroretic of the Spinal Cord of Full-grown Rabbits. Luigi Pilati. *Riv. di radiol. e fisica med.*, November, 1932, IV, 525-534.

From his study the author shows that the neuroreticulum is radioresistant. Only after strong doses was it possible to obtain minor lesions (in the form of ingrowth of neurofibrils), vacuolization of the cytoplasm, thickening of the nodal points, and, in rare instances, signs of disintegration or disorder of the neuroreticulum. By a combined action of radium and freezing there was produced a conglutination of the neuroreticulum of Donaggio in the form of scattered islets amid intact cells, an effect which has

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CONTRAST MEDIA

Iodine Poisoning and Iodism from Lipiodol. D. A. Carmichael. *Can. Med. Assn. Jour.*, March, 1932, XXVI, 319, 320.

Recently introduced solutions and compounds containing large percentages of iodine are now extensively used therapeutically or as opaque substances for radiography and are potential sources of poisoning and iodism. Unless the danger is fully recognized and suitable measures for prevention or timely treatment employed, the inevitable errors or accidents of technic, and the well known idiosyncrasy to iodine, will undoubtedly lead with increased frequency to the reappearance of iodine poisoning.

The author reports two cases of iodism and iodine poisoning following the use of lipiodol for bronchography.

The first case was that of a nurse who received 20 c.c. of lipiodol by the transglottic method. Immediate films showed extensive left-sided bronchiectasis. Six hours later she became acutely ill with vomiting, diarrhea, faintness, intense pain in the hands, wrists, and face, followed by the appearance of marked urticarial wheals over the arms, face, and neck. These coalesced and formed bullous vesicles, many of which were hemorrhagic. The contents of these vesicles quickly coagulated, forming tough crusts beneath which new epithelium slowly formed, ending in complete recovery without scar in three months.

The second case was that of a woman suffering from moderate arthritis, who received 30 c.c. lipiodol by the supraglottic method. Both lower lobe bronchi were well filled, the films also showing a thin line of oil in the gastric canal. Some hours later the patient became nauseated, weak, dyspneic, and was

troubled with vomiting and diarrhea. Marked swelling and blackness of the tongue developed, with hemorrhagic blebs on the eyelids, fingers, toes, buttocks, tip of tongue, and soft palate. Laryngeal edema also developed. Improvement was rapid and recovery was complete in four weeks.

Treatment in both cases was symptomatic, with adrenalin hypodermically and calcium lactate *per os*. The skin lesions were punctured and painted with 1 per cent picric acid solution.

Experimental and clinical evidence shows that iodine absorption from the bronchial mucous membrane is negligible. If, therefore, idiosyncrasy is excluded, absorption in these two instances must have occurred from the gastro-intestinal tract. In both cases the lipiodol was introduced under visual control, and could reach the stomach only secondarily from the trachea and bronchi. How may this occur? Partly by cough and swallowing during the instillation, but certainly in much greater quantity from suppressing cough and substituting clearing the throat and swallowing during the fluoroscopic and radiographic examinations, or failure to expectorate the oil raised by cough later. If this be true even the most exacting transglottic method of administration would not of itself be sufficient to prevent the subsequent appearance of toxic symptoms.

Additional precautions are suggested by the author. The patient should be instructed that at no time during the procedure, or afterward so long as the taste or smell of oil is recognized, should the sputum be swallowed. Careful search will reveal any oil in the stomach, and, if sufficient is found to contain even one grain of iodine, it should be removed by gastric lavage, induced vomiting, or a brisk saline cathartic. The antidote, starch, should be given as

could be demonstrated in either group. The observations suggest that in children who are infected with ascaris and show no response to tuberculin tests the widening in the hilar areas with increase in the bronchovascular markings are possibly due to the repeated migration of ascaris larvæ through the lungs. The changes seen in the roentgenogram are similar to those seen in the childhood type of hilar tuberculosis and may resemble changes following repeated non-specific infections of the lungs.

C. G. SUTHERLAND, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Acute Intestinal Obstruction, Due to Mesenteric Defects Requiring Massive Resection. Charles Reid Edwards. *Jour. Am. Med. Assn.*, July 23, 1932, XCIX, 278-280.

Most of the acquired changes within the mesentery have their origin in inflammatory processes, and unless there is a complete interruption of the circulation, as in mesenteric vascular occlusion, surgical intervention is rarely indicated. Neoplasms involve the mesentery, but in a majority of cases a radical surgical procedure is contra-indicated. Cysts and other tumors developing in this region may require radical surgical measures; however, they are rare. Adhesions frequently demand operation for relief.

Trauma of the abdomen may rupture mesenteric vessels or separate the intestine from its mesentery, causing severe hemorrhage, or it may produce a wound in the mesentery which will allow coils of intestine to pass through, and, later, to become strangulated. Congenital defects do occur. The mesentery may be excessively long or too short; sections may be missing, or there may be anomalous developments in the arrangement of the blood supply. The translucent spaces may be actual openings in the mesentery. Therefore, a hole appears within an anastomotic loop, and it may permit a coil of intestine to pass through.

Intestinal obstruction caused by a passage of a loop of small bowel through this abnormal opening in the mesentery is probably the rarest of all factors responsible for intestinal obstruction, and the infrequency of this condition with a consideration of the extent of its pathologic manifestations prompts this essay. Just what mechanism is responsible for the passage of a loop of bowel through this aperture is a matter of conjecture. The size and shape of the aperture would almost preclude the possibility of a spontaneous reduction, once the bowel had passed through. Once a loop has been projected through this opening, distention within the loop and peristaltic movement serve to force more and more of the intestine through the opening, only to cause strangulation. Early operation is the only

hope the patient has for recovery. The percentage of recoveries has been high when reduction of the bowel could be effected.

C. G. SUTHERLAND, M.D.

Roentgenologic Diagnosis of Neoplastic Diseases of the Stomach. B. R. Kirklin and H. M. Weber. *Am. Jour. Cancer*, September, 1932, XVI, 1134-1143.

The authors review the x-ray signs of neoplastic diseases of the stomach. They stress the fact that at the Mayo Clinic during 1930 almost three-fourths of the gastric lesions following operations were malignant. In case of doubt they feel that one should lean towards the diagnosis of malignancy. They emphasize the desirability of active personal co-operation of the roentgenologist and the clinician. According to the authors, the annual health examination should always comprise a roentgenologic investigation of the alimentary tract.

JOHN R. CARTY, M.D.

Diseases of the Large Intestine. C. C. McClure. *Arch. Surg.*, March, 1932, XXIV, 411-425.

This is a general article on the common diseases and abnormalities of the colon, with comments on these conditions. The article is abundantly illustrated. The author takes up the following conditions: Spastic colitis; ulcerative colitis, pericolicitis; appendicitis; foreign bodies; tuberculosis; diverticula, and carcinomas.

HOWARD P. DOUB, M.D.

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Volvulus of the stomach is of rare occurrence. There is considerable discussion on the part of those reporting cases in the literature as to the proper use of the terms "volvulus" and "torsion," as applied to this rare rotation of the stomach. The authors consider their case to be one of true volvulus, i.e., one of complete rotation through 180 degrees.

The patient, a well-nourished female infant, 4 months old, was admitted to the St. Boniface Hospital, with a history of vomiting and constipation for twenty-four hours. The baby was very ill, the entire epigastrium being occupied by a mass which could be palpated and visualized. Below this tumor mass the abdomen was flat and rigid.

The pre-operative diagnosis was acute intussusception extending into the transverse colon. Operation under ether anesthesia revealed a distended stomach, bluish-black in color, owing to strangulation of its blood supply. The pylorus was in the left hypochondrium. By rotating the pyloric end clock-wise, the stomach regained its normal position, there being no adhesions. When thus released, fluid

been observed by the combined action of x-rays and freezing.

E. T. LEDDY, M.D.

The Placenta and the Reticulo-endothelial System, Especially on the Roentgenography of Placenta. Sh. Katsuya. Jap. Jour. Obstet. and Gynecol., April, 1932, XV, 77-87.

The author believes that the placenta in the pregnant animal is as important an organ of the reticulo-endothelial system as the liver and spleen. Following the work of Radt and Oka, he injected thorium dioxide intravenously into pregnant guinea pigs, rabbits, and mice, made roentgenograms of the animals, and obtained visualization of the placenta.

In the guinea pig, from 2.5 to 4 c.c. of 25 per cent thorium dioxide, divided into two doses, were injected into the vein of the hind limb; in the rabbit, 11 c.c. divided into three doses were injected into the auricular vein, and 3 c.c. in one injection were administered into the tail vein of the mouse.

The author is of the opinion that it may be proved by means of radiography of the placenta that the decrease in the antitoxic function of the reticulo-endothelial system is a very important factor in the toxemia of pregnancy.

J. N. ANÉ, M.D.

The Influence of Irradiated Barley on the Composition of the Growing Bone. Ludwig Pincussen. Strahlentherapie, May 11, 1932, XLIV, 183-192.

Young growing rats which were chiefly fed barley showed more rapid bone development if the barley had been irradiated with ultra-violet light. The type of irradiation is of considerable importance, since barley irradiated too long had much less effect. Definite relations were also found between the weight of the animal and the bones, as well as the ratio Ca:Mg. If barley is kept in storage for a considerable period of time after irradiation, it retains the properties observed in barley fed to the rats immediately after exposure.

ERNST A. POHLE, M.D., Ph.D.

The Hypophysis and the Metabolism of Fat. Antonino Spinelli. Archivio di Radiologia, March-April, 1932, VIII, 290-311.

The author, of the Royal Surgical Clinic of Rome, reports some experiments he did on rabbits, the hypophysis of which was irradiated to effect fat metabolism. The technic employed was 180 K.V., 2 ma., 0.5 zinc plus 2 mm. aluminum filter, 23 cm. T.S.D., and from 1/10 to 1/2 H.E.D. was given at each exposure to temporal fields. In rabbits irradiated with repeated stimulating doses there was no difference between young and adult animals; both added weight more rapidly than the controls, but this growth was more marked in the skeleton than

in the soft parts. In the rabbits treated with a single massive dose of an inhibiting type, the results were variable. Some of the young animals after a transitory arrest in development grew like those which had had stimulating doses; others lagged behind the controls. There was much individual variation among the full-grown animals. Some did not vary greatly from the controls, while others showed marked accumulation of fat. The author concludes that irradiation of the hypophysis has a marked effect on fat metabolism. An extensive bibliography is appended to the paper.

E. T. LEDDY, M.D.

The Influence of Alpha, Beta, and Gamma Rays of Radium on the Aërobreathing of Animal Organisms. Julius Stoklasa. Strahlentherapie, April 13, 1932, XLIII, 685-700.

The author studied the influence of radium on the aërobreathing in different animals. He came to the conclusion that the breathing intensity, particularly of fishes and guinea pigs, is increased by alpha rays but decreased by beta plus gamma rays. The exposure to pure gamma radiation increases the intensity of breathing—however, much less than does exposure to alpha rays.

Other experiments were undertaken in order to explain the etiology of the lung carcinoma in miners in the region of Joachimsthal. It was found that the lungs of animals which were subject to radium exposure for a long period of time showed marked acidity, due to the formation of lactic acid. Other enzymes in the lung, particularly oxidase and peroxidase, were partly destroyed by irradiation. This, of course, made the further decomposition of lactic acid impossible. It also appeared that the CO₂ production as compared with normal lungs was greatly decreased.

ERNST A. POHLE, M.D., Ph.D.

The Lungs of Children with Ascaris: A Roentgenologic Study. A. E. Keller, H. T. Hillstrom, and R. S. Gass. Jour. Am. Med. Assn., Oct. 8, 1932, XCIX, 1249-1251.

Pneumonia and various respiratory symptoms can be produced experimentally by the feeding of ripe pig ascaris eggs.

Workers have from time to time suggested that various pathologic conditions might arise in man as a result of the migration of ascaris larvae through the lungs. Experimentation has shown that during the stage of migration definite pulmonary involvement occurs.

Roentgen examinations were made of 80 children with ascaris and negative tuberculin tests, and a control group of 40 children without ascaris and with a negative tuberculin test. No significant differences in either diaphragmatic or pleural changes

could be demonstrated in either group. The observations suggest that in children who are infected with ascaris and show no response to tuberculin tests the widening in the hilar areas with increase in the bronchovascular markings are possibly due to the repeated migration of ascaris larvæ through the lungs. The changes seen in the roentgenogram are similar to those seen in the childhood type of hilar tuberculosis and may resemble changes following repeated non-specific infections of the lungs.

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The pre-operative diagnosis was acute intussusception extending into the transverse colon. Operation under ether anesthesia revealed a distended stomach, bluish-black in color, owing to strangulation of its blood supply. The pylorus was in the left hypochondrium. By rotating the pyloric end clock-wise, the stomach regained its normal position, there being no adhesions. When thus released, fluid

regurgitated into the mouth, and the tumor was reduced in size. The circulation quickly returned. In the absence of distention, the abdomen was easily and quickly closed. The child's general condition was good. Within the hour a feeding of dextro-maltose was taken. Half an hour later the child vomited and expired in a convulsive seizure.

At postmortem the head was negative, and the thymus weighed 28 grams (normal: from 1 to 12 grams). There were a few small petechial hemorrhages in the pleura and pericardium; the rest of the thoracic contents was normal. The left side of the diaphragm had an opening one and a half inches in diameter, leading into a hernial sac which contained the relatively large spleen. The stomach was of dark red color; the wall definitely thickened; the mesenteric glands were enlarged. The authors conclude that the death was a thymic one.

L. J. CARTER, M.D.

Diverticulosis of the Colon and Sigmoid Carcinoma. H. Strauss. *Med. Klinik*, April 1, 1932, XXVIII, 473-475.

The occurrence of carcinoma of the sigmoid in cases of diverticulosis of the colon is given as 30 per cent in the Mayo Clinic. From other sources it is reported as rare. The author considers the coincidence of the two diseases as unusual. Only once could he demonstrate both lesions in one patient. The case is described and roentgenograms are shown. Three times he has seen "pseudo-carcinomas," that is, an infiltrative sigmoiditis with an inflammatory tumor. In some of these cases only a biopsy can clear the diagnosis. Clinically and roentgenologically, a definite statement as to the benign or malignant character cannot always be made. The roentgenologic appearance of diverticulosis has been described by many authors in detail, and it is known that diverticula may be found in a large percentage of persons over 45 years of age. By an infection of the diverticula, a diverticulitis develops which may occasionally lead to phlegmonous processes and abscesses. These may present all the clinical and roentgenologic features of a carcinoma.

H. W. HEFKE, M.D.

Chronic Ulcerative Colitis Associated with Peptic Ulcer. J. Arnold Barger and Andrew B. Rivers. *Med. Clin. N. A.*, May, 1932, XV, 1419-1429.

The authors studied the association of peptic ulcer and chronic ulcerative colitis in 500 cases of the latter condition. While it was expected that these conditions would be found to coexist frequently, definite evidence of an associated peptic ulcer was found in only 16 cases of chronic ulcerative colitis. Twelve of the 13 ulcers which were disclosed roentgenologically were duodenal, and one was gastric.

In eight cases the patient's original complaint was indicative of ulcer and in five cases symptoms of ulcerative colitis preceded those of peptic ulcer. It was noted in this series that treatment, if successful in relieving the symptoms of colitis, also resulted in quiescence of the syndrome of peptic ulcer. As a rule, no definitely characteristic syndrome of uncomplicated ulcer was obtained, except in five cases.

The authors are of the opinion that in this series of cases there was some evidence of allied etiology of chronic ulcerative colitis and peptic ulcer. However, the rarity of association of the two conditions is noteworthy. It is believed, however, that the possibility of the association should be remembered and that all patients with chronic ulcerative colitis and gastric symptoms should have a thorough examination of the stomach and duodenum.

J. N. ANÉ, M.D.

The Diagnostic Significance of Hematemesis. Andrew B. Rivers and Dwight L. Wilbur. *Jour. Am. Med. Assn.*, May 7, 1932, XCVIII, 1629-1631.

Hemorrhages of the gastro-intestinal tract are often dramatic and alarming, but the primary hemorrhage is rarely fatal. It is sometimes impossible to discover the source of the bleeding, even at operation or necropsy. Hasty surgical treatment is frequently ineffective in controlling bleeding. In 668 cases studied, 90 per cent were found to have some intrinsic lesion of the stomach, duodenum, or jejunum; more than 75 per cent were caused by duodenal, anastomotic, or benign gastric ulcer. Duodenal ulcer, carcinoma, and gastric ulcer were responsible for 50, 13 and 6.4 per cent, respectively. Cirrhosis and splenic anemia and that from all other causes totaled only 9.6 per cent. Diseases in which varices are likely to develop accounted for 5.5 per cent of cases in these series.

C. G. SUTHERLAND, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

The Cholesterol Function of the Gall Bladder. Editorial. *Jour. Am. Med. Assn.*, Sept 24, 1932, XCIX, 1086.

The concentrating activity as demonstrated by Rous and McMaster, in 1921, served to renew interest in the gall bladder and initiated a series of investigations which have been fruitful. This organ has an important motor function in the discharge of bile into the duodenum. Besides water and other substances it absorbs calcium and bile salts. It secretes mucus and makes bile more acid. It is now generally accepted that the gall-bladder mucosa absorbs from the bile cholesterol which is present in its lumen. It is agreed that in the presence of inflammation the lipoid is excreted by the gall-bladder wall. The demonstration of excretion by the gall

bladder has led to a convincing explanation of the pathogenesis of the well-known "strawberry gall bladder." The accumulation of cholesterol under the mucosa is due to the fact that further excretion has become impossible, because the bile is so saturated that it can no longer take up any more of the lipoid. This idea is substantiated by the observation that such bile contains a tremendously high concentration of cholesterol and often exhibits shimmering crystals of it in suspension. The rôle of bile salts in promoting the solution of cholesterol is a factor of great importance. Unlike cholesterol, the inflamed gall bladder absorbs bile salts and thus leads to conditions which render the bile even less able to take up the lipoid and, in fact, cause precipitation of it in the form of crystals or about other centers where it is converted into actual stones over the course of time.

C. G. SUTHERLAND, M.D.

GENITO-URINARY TRACT (DIAGNOSIS)

Renal Anomalies: Case Reports. J. A. H. Magoun. *Jour. Urol.*, April, 1932, XXVII, 435-463.

The author divides his cases of renal anomalies into eight groups, as follows:

1. Cases with unilateral reduplication of the renal pelvis and ureter, without clinical evidence of pathology either within or out of the kidney.
2. Cases with unilateral reduplication of the renal pelvis, with partial or complete reduplication of the ureter, accompanied by extrarenal pathology.
3. Same as Groups 1 and 2, with pathology of the urinary system.
4. Cases with bilateral complete reduplication of the pelvis and ureter.
5. Cases with horseshoe kidney.
6. Cases with ectopic kidney.
7. Cases with hypoplastic kidney.
8. Cases with faulty rotation of the kidney.

This paper presents several points of interest worthy of discussion and consideration.

The question arises as to whether or not uncomplicated reduplication of the ureter and pelvis can produce symptoms. All the patients in this series complained of pain on the side in which the deformity existed. It would seem possible that an anomalous nerve supply may be present and produce a nephralgia similar to that for which Papin divides the renal nerves.

The majority of the cases were complicated by some pathologic condition within or without the urinary tract.

It has been observed that occasionally following plastic operations on the renal pelvis the anatomic condition is unimproved in spite of a symptomatic cure. A post-operative pyelonephritis occurring in a kidney previously free from infection may cause a dilatation of the pelvis and explain this paradox.

Ectopic kidney due to the deformities of its blood vessels and its connective tissue surroundings is frequently subject to disease. Radical surgery would seem best in its treatment.

The employment of various tests of differential renal function is advocated. A pyelogram showing a large hydronephrosis does not necessarily mean that the hydronephrotic kidney does not support life. The possibility of an opposite hypoplastic kidney should always be considered.

Many interesting roentgenograms illustrative of the conditions described accompany the article.

DAVIS H. PARDOLL, M.D.

Intravenous Urography: A New Diagnostic Procedure for the General Practitioner. Miley B. Weston. *Urol. and Cutan. Rev.*, May, 1932, XXXVI, 296-307.

In 1923, Rowntree and his associates in the Mayo Clinic obtained faint outlines of the renal pelves and bladder after the intravenous injection of 200 c.c. or more of 15 per cent sodium iodide solution.

Uroselectan or iopax was prepared in 1929, by Binz, von Lichtenberg, and Swick. Shortly thereafter Bronner, of Cologne, gave skioldan to the medical profession. Von Lichtenberg later reported favorable results with neo-iopax (Uroselectan B), which contains only three-fifths as much iodine as does iopax or skioldan.

As a rule, roentgenograms made using the intravenous method are generally less clear and do not always delineate the minor degrees of deformities in the calices, because there is a 5 per cent concentration as against a 12 per cent or 15 per cent in the retrograde method. The elimination of the contrast substance is an index of kidney activity; therefore, in cases in which the affected kidney is not functioning, intravenous pyelography will prove of no value in outlining the pelvis.

Neo-iopax and skioldan are dispensed in sterile solution ready for use, whereas the iopax powder has to be diluted and autoclaved. The author is of the opinion that a child of 7 years is able to tolerate a full dose of neo-iopax, and one of six weeks, a quarter dose. The gravity method of administration is considered safe and is preferred by the author to the syringe method. Fifteen minutes should be allowed for the injection of the 100 c.c. of solution of iopax, while skioldan, employed in an average dose of 50 c.c., and neo-iopax, of which only 20 c.c. are used, can be given much faster. When skioldan is used, roentgenograms should be made at 15- and 45-minute intervals, the bladder being emptied before the second film. In the case of uroselectan the greatest concentration is often found at one and a quarter hours, a third film becoming necessary. When using neo-iopax roentgenograms should be made at 5, 15, and 30 minutes after injection.

Intravenous pyelography is dangerous when em-

ployed in patients with advanced renal insufficiency and general weakness. Particularly prone to reactions are cases of idiosyncrasy to iodine, hyperthyreosis, pregnancy, and active tuberculosis, thyrotoxicosis, acute and chronic renal diseases. In cases of renal tumors, polycystic kidneys, and purulent infection, because of failure in the excretion of the substance, the roentgenograms may prove misleading. For this reason it has proved a disappointment in infants with pyuria.

Intravenous pyelography is indicated when cystoscopy is impossible, as in infants, or difficult, as in cases of contracted bladder, hypertrophy of the prostate, urethral stricture, extensive vesical neoplasms, stenosis of the ureter. It should be used as a routine in the case of suspected ureteral stone. If the drug is eliminated equally well by both kidneys, there is no stone. Double kidneys showing three pelvis are commonly found by retrograde pyelography, but the fourth pelvis does not show without the intravenous medium because of the peculiar ending of the ureter. In cases in which both methods of pyelography are used it is important that the intravenous roentgenograms be made first, as the presence of a catheter in the pelvis may interrupt the excretion of the substance by that kidney.

While intravenous pyelography is considered a valuable adjunct in diagnosis, it should be remembered that the value of the method depends upon the accuracy of interpretation and the competency and experience of the roentgenologist. In the author's opinion intravenous urography will never eliminate cystoscopic examination, for valuable additional information can be obtained in most cases by the use of this procedure.

J. N. ANÉ, M.D.

GYNECOLOGY AND OBSTETRICS

A New Case of Protrusion of the Acetabulum of Obstetrical Importance. (Contribution to Obstetrical Measurement of the Pelvis.) Ludwig Sinn. *Röntgenpraxis*, October, 1932, IV, 856-865.

Protrusion of the acetabulum, not a disease in itself but the result of several different etiologic factors, is not so rare as one used to think. It might be of great importance in obstetrics. The roentgenographic methods of pelvic mensuration are numerous, which seems to indicate that none is entirely satisfactory. The simplest and yet most accurate appears to be Thoms' method, the details of which should be read in the original. The literature contains a description of a case. Obstetrical difficulties depend on the amount of protrusion into the pelvic lumen, which can be determined by roentgenologic means.

H. W. HEFKE, M.D.

Myosarcoma of the Uterus, with Lung Metastases. Karl Herman. *Röntgenpraxis*, March 1, 1932, IV, 211-213.

Uterine myomas with malignant (sarcomatous) degeneration are not frequent. Such a case is described in detail. Locally, the tumor appeared benign, but anemia, fever, loss of weight, and cachexia indicated malignancy. The tumor was removed surgically and found to contain areas of malignant degeneration. About five months afterwards the patient's condition grew worse and metastases could be demonstrated in the right hilus and lung.

H. W. HEFKE, M.D.

HEART AND VASCULAR SYSTEM (DIAGNOSIS)

Suppurative Pericarditis: Report of a Case. Edwin M. Miller. *Jour. Am. Med. Assn.*, March 12, 1932, XCVIII, 873-875.

Suppuration within the pericardium is never primary. It may follow a penetrating wound; it may appear as a metastatic abscess secondary to a general infection of the blood stream; it may develop by direct lymphatic extension from a suppurative focus within the mediastinum, lung tissue, or pleural space. Clinically, it is seen most commonly after pneumonia, and the pneumococcus is the prevailing organism.

The author reports one case which clinically was considered diffuse bronchopneumonia. A roentgenogram revealed a large, rounded cardiac shadow with relatively clear lung fields, which led at once to the suspicion of pericarditis with effusion. Aspiration revealed the presence within the pericardium of pus containing the pneumococcus. Surgical drainage was instituted, followed by recovery of the patient.

C. G. SUTHERLAND, M.D.

Influence of the Weather on Man, Demonstrated by the Relations between the Physiologic Fluctuations of the Blood Pressure and Air Mass Changes. Kurt Franke. *Strahlentherapie*, March 9, 1932, XLIII, 517-546.

The author studied the daily fluctuations of the blood pressure in persons with increased and normal pressure, and in about 90 per cent, he found the variations to be of similar nature in both groups. During the period from 1924 to 1927, he found approximately six times a month definite variations in blood pressure lasting from one to three days. Fluctuations did not start on the same day in all persons. It was difficult to establish definite relations between the blood pressure changes and the various components of the weather. However, in about 80 per cent of air mass changes, there was a definite fluctuation in the blood pressure. Air masses com-

ing from the polar region and Eastern continent produced an increase, and those coming from the warmer Atlantic region and subtropical areas caused a decrease in the blood pressure. It is possible that the change in the air ionization may be responsible for the observed blood pressure fluctuations, particularly in view of the investigations of Dessauer with unipolar charged air.

ERNST A. POHLE, M.D., Ph.D.

HEART AND VASCULAR SYSTEM (THERAPY)

The Therapeutic Application of the Roentgen Ray in Angina Pectoris. E. C. Samuel and E. R. Bowie. *Am. Jour. Roentgenol. and Rad. Ther.*, June, 1932, XXVII, 870-876.

Nineteen patients have been given small series of x-ray treatments supplementary to other more widely accepted therapeutic measures for angina pectoris. All were individuals past middle life, fifteen being male and four female. Practically all had x-ray therapy only after measures ordinarily employed had proven unsuccessful. As a result of adding irradiation to the treatment, none required surgery or injection. The technic employed was: 140 K.V.P., 20-inch distance, Cu $\frac{1}{4}$ mm. plus Al 1 mm., from 40 to 50 milliampere minutes, giving 150 r units per dose. The field was the cardiac area anteriorly and occasionally posteriorly. Treatments were given every two weeks until four treatments had been administered, further treatments being given at six- to eight-week intervals. Benefit was often not observed until the third or fourth treatment. Roentgentherapy in this series proved rather uniformly successful and worthwhile in the experience of the patients and in the estimation of the clinicians caring for these cases.

J. E. HABBE, M.D.

THE JOINTS

The Meniscus of the Knee Joint in Roentgenograms. Otto Dittmar. *Röntgenpraxis*, May, 1932, IV, 442-445.

That only a diseased, calcified meniscus may be demonstrated on roentgenograms is the opinion of most authors. Dittmar believes that it might be possible to show the meniscus and the medial, real joint-slit if one fixes the knee in abduction. He succeeded in a normal knee of a child and a pathologic knee of an adult (injury to the cartilage of the knee). No contrast material or air was used for this purpose. These findings prove that not every roentgenologic meniscus must be pathologic.

H. W. HEFKE, M.D.

Calcification of the Meniscus in the Roentgenogram (Primary Meniscopathy). A. Henrichsen. *Röntgenpraxis*, May, 1932, IV, 403-405.

Only 18 cases of primary non-traumatic calcification of the menisci have been reported, 14 of them by Mandl. This condition is often bilateral, a fact which accounts for the non-traumatic genesis. In the author's case the roentgenograms also showed characteristic lines of calcification in the region of the menisci of both knees. Degenerative processes (round-cell infiltration, degeneration of the cartilage, edema of the connective tissue, formation of small cysts, and circumscribed or diffuse calcium deposition) are evident on histologic examination. The author believes that arthritic processes, in his case, are the basis of the changes in the menisci.

H. W. HEFKE, M.D.

THE KIDNEYS

Horseshoe Kidney: A Report of Five Cases. Joseph A. Lazarus. *Jour. Urol.*, April, 1932, XXVII, 471-487.

The author draws the following conclusions:

- (1) Horseshoe kidney is not a rare anomaly, occurring in about 0.1 per cent of normal persons;
- (2) The above mentioned kidneys are relatively more prone to pathologic lesions than are normally formed kidneys;
- (3) There are no symptoms characteristic of horseshoe kidney. When symptoms occur, they are due to some associated pathologic lesion;
- (4) Most cases of horseshoe kidney have been diagnosed at the time of operation or at post-mortem examination;
- (5) A careful study of a good flat kidney roentgenogram will usually suffice to lead to the suspicion of this anomaly by showing the proximity of the renal silhouette to the vertebral column, by the obliteration of the psoas margins in part or in their entirety, and by the failure to visualize one or the other of the renal poles;
- (6) Pyelography clinches the diagnosis of horseshoe kidney by showing the bizarre pelvis and calices usually pointing anteriorly and approximated to the midline and shortening of the ureters;
- (7) The best treatment for an extensive suppurative lesion, tumor, or tuberculosis involving one half of a horseshoe kidney is heminephrectomy. All other diseases involving horseshoe kidneys are treated in exactly the same manner as are similar diseases in normally formed kidneys;
- (8) The diagnosis of horseshoe kidney prior to operation will greatly facilitate operative procedures upon such kidneys.

DAVIS H. PARDOLL, M.D.

Calculus Disease Complicating Horseshoe Kidney. J. Sydney Ritter and Leo A. Shifrin. *Urol. and Cutan. Rev.*, May, 1932, XXXVI, 311-313.

The authors discuss the embryology, diagnosis, and treatment of horseshoe kidney associated with calculi and report a case of this rare condition.

Horseshoe kidney is a very early embryologic defect. As early as the 8 mm. embryo, either the upper or the lower pole of one kidney may fuse with the upper or lower pole of the kidney on the opposite side, or they may unite centrally. Fusion of the lower poles is the most common entity encountered, because these two poles are nearer to each other during the development of the kidneys. The amount of kidney parenchyma present in this bridge of union depends upon the time of fusion of the kidneys. Since the pelvis and ureters develop separately and earlier, they are not involved in this anomaly but cross the commissural kidney tissue anteriorly.

The x-ray has proved of considerable value in the diagnosis of renal calculus disease and horseshoe kidney. In addition to the shadows of the calculi on the roentgenogram, there is usually a suggestion of a connecting bridge between the kidneys. The authors are of the opinion that a definite diagnosis of horseshoe kidney can almost always be made by the use of intravenous urography. The importance of correct pre-operative diagnosis is emphasized.

Horseshoe kidney alone may cause no symptoms, but the associate calculi usually produce sufficient subjective symptoms to make the patient consult a urologist. Anterior pyelotomy, which does not require delivery of the kidney into the wound, is the operation of choice.

J. N. ANÉ, M.D.

Carbuncle of the Kidney (Metastatic Staphylococcus Abscess of the Kidney Cortex). Leo Brady. *Jour. Urol.*, March, 1932, XXVII, 295-316.

A case of renal carbuncle is reported, accompanied by a review of the literature on this subject.

The essentials of a diagnosis are a history of a preceding staphylococcal infection of the skin or of the respiratory tract. The urine is usually normal. A palpable mass may be felt under the costal margin on the affected side, particularly if accompanied by a perinephritic involvement.

The findings in the pyelogram are those usually found in a tumor of the kidney, namely, obliteration of one calyx, with elongation of another, due to

the pressure of the mass exerted on the pelvis. The differential phthalein test may be of value in showing diminished function on the affected side.

Perinephritic abscess and multiple septic embolic abscesses of the renal cortex are to be considered in the differential diagnosis.

The treatment varies according to the extent of the condition or the technic of the surgeon. Nephrectomy, resection, enucleation, and simple exposure, with drainage, are recommended.

The pyelo-ureterogram of the case reported and a bibliography accompany the article.

DAVIS H. PARDOLL, M.D.

RADIATION INJURIES

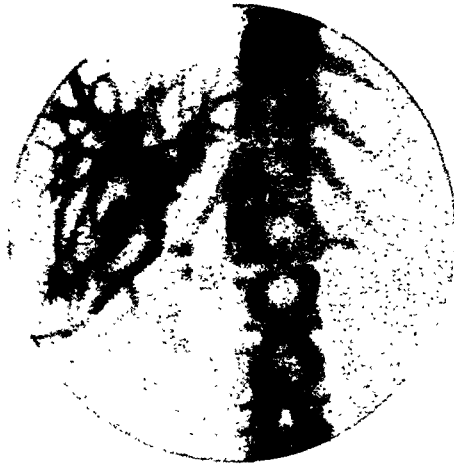
Extensive Roentgen Ulcer, in a Patient with Diabetes, Healed after Six Years' Duration. Gustav Singer. *Strahlentherapie*, May 11, 1932, XLIV, 147-160.

A woman, 46 years of age, was admitted to the author's clinic in March, 1931. She had had uterine hemorrhage, in 1925, and received at that time X-ray therapy over the posterior splenic region. A severe reaction followed which resulted in the development of an extensive roentgen ulcer. She had to remain in the hospital for three years, undergoing treatment for this ulcer, and was kept under observation and ambulatory treatment for the following two years. The patient, who also developed diabetes, suffered from such severe pain and insomnia that morphine had to be given. She succeeded in obtaining this drug and reached a daily dose of 0.5 gram.

When seen in March, 1931, there was a roentgen ulcer 18 cm. long, 12 cm. wide, and 3 cm. deep in the left lower back at the height of the eighth dorsal vertebra. The base of the ulcer was covered by granulations and thin pus. The Wassermann reaction was +4. Insulin did not have any effect on the healing of the ulcer, therefore, non-specific protein injections were given. At the same time withdrawal treatment for the morphine addiction was started. Under the protein treatment the ulcer began to heal and fill in very slowly, and a scar developed. Several photographs show the progress of the healing. It was interesting to note that the diabetes was also favorably influenced by the protein injections. A sequestrum of the ninth rib was removed in March, 1932, and the wound was healing well at the time the report was written.

ERNST A. POHLE, M.D., Ph.D.

TECHNIQUE OF INJECTION



Illustrating injection through abdominal postoperative biliary fistula of two months' duration with incomplete stricture of the common duct. 1. Tube in sinus tract. 2. Stump of gall-bladder. 3. Common duct with small quantity of Lipiodol passing into duodenum. The hepatic ducts down to the very fine intrahepatic biliary radicles are outlined due to reverse flow above the stricture.

Photo, Ginzburg and Benjamin

BILIARY FISTULAE

Ginzburg and Benjamin recommend the following procedure:

Prior to the injection, the Lipiodol is warmed and whatever bile is present in the sinus is aspirated. If a tube is still in situ, gravity will suffice to outline the ducts. The tube should be removed before a plate is taken as it may obscure the picture. Where the skin opening is small and the tract is narrow and tortuous, it is frequently necessary to use some degree of pressure in order to force the Lipiodol into the duct system. A syringe with a rubber urethral tip attached to the nozzle should be used.

The skin should always be wiped dry of Lipiodol before the plate is taken, or confusing shadows will appear.

In order to prevent the escape of the injected fluid, the sinus should be plugged and strapped over.

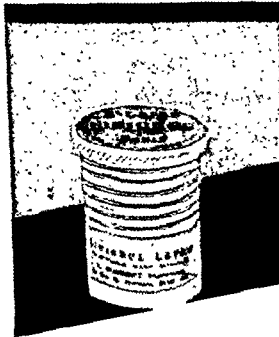
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Turn the page for technique of injection in "Intraspinal Lesions" and "Chest Roentgenology".

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Seminal vesicles. Normal. Lipiodol diluted with paraffin oil. Injection of 2 c.c. by inguinal route after dissection of spermatic cord and catheterism of vas deferens. Both sides injected, both visualized. The vasa are quite visible as well as the delicate contours of the vesicles. An excess of Lipiodol had run into the bladder, but it was voided with the urine previous to radiography.

Photograph from Sicard and Forestier

SEMINAL VESICLES

Sicard and Forestier mention two routes which may be chosen for the injections:

1. The natural, via the urethra after catheterization of the ejaculatory ducts through the urethroscope. The technique of this injection does not differ from the one used by urologists in irrigating the vesicles through the ejaculatory ducts.
2. The surgical, via the inguinal canal after exposure of the spermatic cord. The skin is disinfected and anaesthetized at the level of the scrotum. A short incision is made; the cord is exposed and dissected by means of a grooved director. Then, having carried the local anaesthesia to a greater depth, the vas is liberated and a small trocar, 5/10 mm.

in diameter, is inserted through its wall, axially and upwards in the directions of the vesicles. A syringe with Lipiodol is attached to the trocar and the oil is injected.

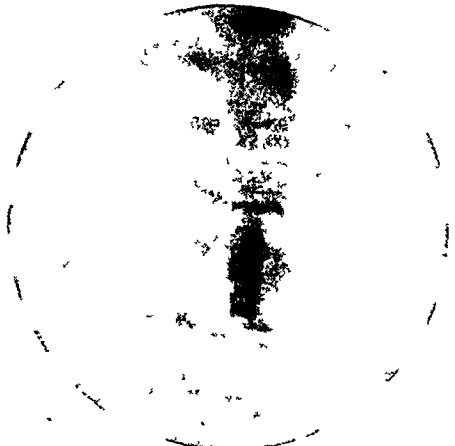
Pure Lipiodol is too viscid for this purpose and Sicard and Forestier recommend its dilution with paraffin oil. A dose of 2 to 3 c.c. is generally sufficient to outline the vesicles. The injection is quite painless.

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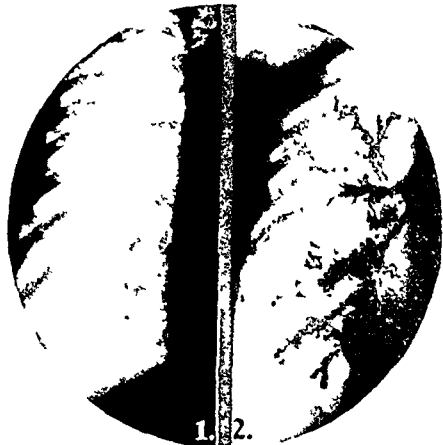
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ADDRESS

TECHNIQUE OF INJECTION



X-ray of spinal column, after a cisternal injection of Lipiodol, showing complete block at the level of the eighth dorsal vertebra, by an intradural tumor



1. Roentgenogram before injection. Appearance practically normal. 2. Same after Lipiodol injection. Bronchiectatic abscess in right lower lobe previously invisible. Photos courtesy Dr. David H. Ballon, Montreal, who uses the bronchoscopic technique

INTRASPINAL LESIONS

The intraspinal injection of Lipiodol is best accomplished through a cisternal puncture. Globus and Strauss recommend that a period of at least 5 days elapse before introducing iodized oil after spinal puncture has been done, so as to avoid any possible error which might occur as a result of loss of spinal fluid. The back of the head is shaved as far up as the external occipital protuberance. One-half hour before the cisternal puncture is carried out, a hypodermic injection of morphine $\frac{1}{4}$ grain and scopolamine $\frac{1}{50}$ grain is given. The cisternal puncture is done with the patient lying on his side; the head resting on a pillow which is placed in the hollow of the neck so as to keep the head exactly in line with the axis of the body. Insert the needle and inject 2 c.c. of oil. Before the needle is withdrawn the stylet is reinserted so as to clear the lumen of the needle of the remaining small amount of iodized oil. It is again withdrawn so as to allow a few drops of cerebrospinal fluid to escape.

The needle is then withdrawn and the patient is allowed to sit up. The first roentgenographic examination is made a half hour later. If it is normal, no reexamination is necessary; if some of the oil is arrested, at a higher level, another series of pictures is taken on the following day in order to see whether the iodized block is permanent.

Subarachnoid injections should be avoided, at least until all other means of diagnosis have been exhausted

"Iodized Poppyseed Oil 40%"

CHEST ROENTGENOLOGY

(By the supraglottic method)

The procedure for the supraglottic method is outlined by Sante:

The patient sits in an upright position facing the operator. The pharynx and larynx should be sprayed with a 5 per cent cocaine or butyn solution. As a rule the use of a laryngeal mirror is not necessary. The patient is instructed to grasp the tongue with a piece of gauze and pull it forward. Oil previously warmed to body temperature is dropped directly into the glottis, while cords are open. About 15 to 20 c.c. of oil are sufficient as a rule. In most instances, all that is necessary is to drop oil on back of tongue and if patient breathes deeply the oil will run down into the lungs with very little difficulty. If the right lung is to be filled, the patient leans to the right, holding head erect; if the left lung is to be examined, the patient is inclined to the left.

If the middle or upper lung fields are to be studied, place the patient on a tilting table in the recumbent position lying on the affected side. The head is elevated by pillows and turned upwards. Anaesthetize and inject as in upright position. Immediately after the injection tilt the table so that the head and thorax are pointing downward.

Turn the page for technique of injection in "Biliary Fistulae" and "Seminal Vesicles"

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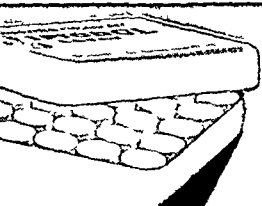
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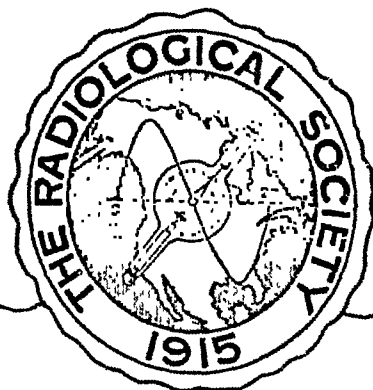
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SOME X-RAY STUDIES OF THE CIRCULATION¹

By WALTER J. MEEK, Ph.D., Professor of Physiology, University of Wisconsin Medical School, Madison

PERHAPS no discovery of modern times has had applications in more divergent scientific fields than have x-rays. Their use in medicine to outline internal organs and foreign bodies is, of course, now a commonplace, but not so many are aware of the assistance of x-rays in studying function. I wish to present the results of some physiologic investigations on the circulation which have been made possible by x-rays.

The circulation as a whole is a device to furnish oxygen to the tissues and to remove their wastes. In accomplishing its purpose, three factors are chiefly concerned: oxygen transportation and utilization, pulse rate, and cardiac output per beat. Two of these concern the heart and are capable of being studied roentgenographically.

A few years ago Henderson bemoaned the fact that three hundred years after Harvey, we still could not answer the simple questions: "How much blood is expelled at each heart beat?" and "How does this vary with pulse rate, venous pressure, rest, exercise, and various other conditions?" Great progress has since been made, but I dare say that if to-day you asked all the students of the circulation to name the one contribution they would most like to make,

the answer would be well-nigh unanimous: a simple, accurate method for determining the output of the heart. The heart is a pump, without other physiologic function. If the output of the heart were determined, the clinician could rate the efficiency of the heart with a degree of certainty now entirely unknown.

Harvey, himself, first estimated the volume of the circulation by measuring the capacity of the cardiac chambers in cadavers. In recent times the cardiometer and the Starling heart-lung preparation have been of the greatest usefulness in determining cardiac output in the experimental animal. Although such methods are of extreme importance, they really show only what the heart can do under most abnormal conditions. To secure the circulation volume in the intact animal has proved one of the most difficult problems in all physiology. It was not until the technic of blood gas analysis was developed that the suggestions of Fick, made in 1870, could be carried out. Fick pointed out that, if we knew the O_2 content of arterial blood and subtracted from it the O_2 content of venous blood and divided the total O_2 consumed in one minute by this figure we should have the amount of blood passing through the heart per minute, or the minute-volume of the circulation. On dividing this latter figure by the pulse rate

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we should, of course, have the stroke volume or output per beat.

The Fick principle has now been applied to the respiration of many gases other than oxygen. Nitrous oxide, carbon dioxide, ethyl iodide, and acetylene have proved the most useful. In reviewing the work of those who have used the gas methods, it may be seen that the cardiac output at rest ranges all the way from 3 to 10 liters for minute volume, and from 50 to 160 c.c. for stroke volume. Such variations do not inspire confidence in the gas method as a whole. Its difficulties and limitations are obvious. The necessary co-operation of the patient excludes many subjects, particularly many of those on whom we most desire information. Technically there is always some doubt as to the time required for pulmonary mixing, the solubility of the gas in the blood, and whether or not the samples of alveolar air were secured before the blood carrying the gas had made a round of the circulation.

In view of the variable figures presented by the gas methods, Dr. Eyster and I have attempted to determine heart size and output by an entirely different method, namely, that of the x-ray. The data actually secured are the silhouette areas in the frontal plane.

Many ingenious methods have been devised to interpret cardiac shadows in terms of heart size. Longitudinal and transverse diameters of the ventricles, perpendiculars to these diameters, the shift in position of outline due to a known shift in tube position and area of the shadow have all been used. For experimental, as well as clinical purposes, we believe the silhouette area is most useful.

If the heart were a sphere, it would be easy to deduce the heart volume from its shadow. Although they are not spheres, hearts are similar enough in shape so that the area of the shadow must bear some mathematical relation to the cardiac volume. This

matter has been investigated by Bardeen (1), who finds that, with human cadavers, if the silhouette area is comparable with the known volume of that heart, the relationship between the two may be expressed by the mathematical formula, $0.53 A^{3/2}$, A being the area of the heart shadow. Skavlem (2) in our own laboratory has repeated this study on dogs, and we have recently confirmed his results in a larger series. It appears that in the dog the formula $0.44 A^{3/2}$ expresses the relationship between silhouette area and volume.

In this way the volume of the heart may be determined from its x-ray shadow within an accuracy of 90 per cent or better. The borders at the base and apex cause some difficulty in man, but in experimental studies of the dog the area is outlined with great ease. Absolute accuracy is, of course, not claimed for the roentgenographic method of determining cardiac volume, but successive measurements are consistent enough to permit one to point out its value in both physiology and clinical medicine.

As it is usually taken, the silhouette area represents the diastolic size of the heart. For many cardiac problems this is sufficient, particularly in the light of Starling's law of the heart. The heart, however, is a pump, and its output is the most important observation that can be made regarding its function. The volume determination just described offers a possibility of reaching this goal.

The intraventricular pressure curve shows that there are two periods in the cardiac cycle in which the heart is a closed chamber, one the period of rising tension when the ventricles are fullest of blood, and the other just after the period of emptying when the semilunars are closed, the auricular-ventricular valves not yet open, and the heart is most nearly empty. If an x-ray film could be taken in each of these periods, the difference in area would be related to the blood ejected.

Although this is not easy to do, it may be

accomplished by a system of keys, circuit breakers, and a plate changer. Closing the primary circuit for the first picture must energize a solenoid circuit breaker which terminates the exposure in about 0.02 second, for the period of rising tension lasts only about 0.04 second. The solenoid of this circuit breaker may also conveniently trip a spring which jerks away the cassette, exposing the next one behind. Closing the primary key also starts a weight falling which closes a second circuit with its circuit breaker, thus making a second x-ray film.

The real problem is to get the first shot placed correctly. Arterial pulsations come too late to be used. It is possible to listen to the heart sounds and trip the switch at the proper moment, but this method has proved cumbersome. The most practical device so far has been to watch the shadow of the electrocardiographic string and throw the switch at the up-stroke of the R wave. The falling body must be so adjusted that it closes the second circuit at the end of the T wave, which is practically identical with the period of falling tension. Induction from the x-ray discharge will cause a short period of vibration in the electrocardiogram, and this conveniently records the exact moment the silhouettes were taken.

So far it must be admitted that the accurate placing of the x-ray films has been largely a matter of chance. To perfect the apparatus the first exposure should be made automatically. Considerable attention has been given to this, but, although Dr. F. J. Hodges, who has worked on these problems with us, has succeeded in amplifying the current caused by the shadow of the electrocardiogram string falling on a photo-electric cell, we have not yet been able to make it throw a switch in the primary circuit without instability and undue lag. It is possible that direct amplification of the heart currents may give satisfactory power.

In spite of all difficulties we have now succeeded in getting satisfactory records from 40 individuals during rest in the erect position. These subjects, all students in good health, had an average cardiac output of 52.1 c.c. per beat. The average minute volume was 4.0 liters. The minute volume per square meter of body surface has not yet been calculated, but it is approximately 2 liters.

On comparing our results with those of other workers, it may be seen that they agree most closely with the recent figures submitted by Grollman (3) who uses the Marshall-Grollman acetylene method. It is of interest to know that Grollman (4) has recently checked his method by making direct output determinations from the O_2 content of blood drawn by needle punctures from the right ventricles and radial arteries of human subjects. Our results, then, are not only of value in giving definite figures on cardiac output, but they help establish the validity of the acetylene gas method.

The chief objections to the x-ray method are the subjective ones involved in outlining and measuring the silhouette areas with the planimeter. In some cases in which the heart rests low on the diaphragm, it must be admitted that the measurements are difficult to make. It has been pointed out by Hamilton (5) that the auricles are filling while the ventricles empty, which also involves a certain error. It is probably for this reason that our measurements have run a little lower than those of Grollman. In spite of these difficulties, the method does show the variation between diastolic and systolic size which may be interpreted in terms of cardiac output. The method is applicable to patients in almost any condition. With improvement in the technic of taking the exposures, we hope it may have definite clinical applications.

One of the questions long debated in physiology is whether or not in exercise the

minute volume of the circulation is increased by size of stroke as well as by increased heart rate. We now have a series of 17 experiments in which cardiac output was determined before and during light exercise. An increased output per beat as well as an increased rate was seen in 14 of the 17. Three increased their circulation by acceleration in rate alone. There are then normal increases in stroke volume. In the experiments cited, these average about 30 per cent. How much greater the increase may be in heavy work, of course, we can not say.

Ordinarily single x-ray films of the heart are taken with exposures long enough to secure the diastolic size. If these silhouettes mean anything to us, we must know some of the factors that determine the diastolic size of the heart. The most important of these is the venous pressure at the heart level. This, in turn, is determined by various other factors, the most important of which is probably the "venopressor" mechanism of Henderson (6). That the heart dilates with a rising venous pressure may be demonstrated in the experimental animal by the injection of a 6 per cent acacia solution, direct measurement of venous pressure low down in the right jugular, and by making simultaneous roentgenograms of the heart. If the rate is controlled, the heart dilates until the venous pressure reaches between 100 and 130 mm. of water, beyond which there is no longer any effect. Within limits, this distention of the heart is a physiologic phenomenon. According to Starling's law, the lengthened fibers should respond with an increased contraction and a larger output. In five dogs we have found this to be the case. In one animal, on raising the venous pressure from 1 to 17 cm., the output as determined by x-rays increased from 9 to 14.9 cubic centimeters. In another, the increase was over 200 per cent.

In the experimental animal, then, the venous pressure is definitely related to heart

size and output. There is little doubt that the same relations hold in man. Here, however, we cannot secure the venous pressure at the heart level, but even an increased peripheral venous pressure is usually accompanied by a dilated heart. We have tried to have individuals control their venous pressure by holding the breath, but the accompanying variations in heart rate have obscured the results.

In all studies of diastolic cardiac size, the heart rate has been a complicating factor. A study of this influence has been of interest in the interpretation of clinical films and, theoretically, for its bearing on certain problems of cardiodynamics. It has not always been appreciated that heart rate has an immediate and marked effect on venous pressure. In a slowly beating heart, the output does not keep up with the inflow, the venous pressure rises, and there is dilatation. With a rapid rate, the venous cisterns are emptied, venous pressure falls, and the heart decreases in size. In the dog, rates of from 50 to 100 show little variation in heart size, but, beyond 100, the decrease is rapid and somewhat proportional to the rate until, at 200, the minimal heart size is reached. In man much the same has been found. Hodges, in our laboratory, gave nine individuals atropine, thereby raising their rates to about 130. The silhouettes at the highest rate decreased at times as much as 16 per cent, a figure sufficiently large to have a bearing on the interpretation of a cardiac film. That the rate is not important in itself, but works through its effect on venous pressure, is shown by the fact that, if the venous pressure is held constant by infusion, the rates may vary in animals from 60 to 210 without changing the silhouette area. The period of cardiac filling must, therefore, be shorter than was previously supposed.

After all these factors are studied, the question still remains. What is the normal

area of the heart shadow for any given individual? Differentiation of the enlarged heart from the normal is the most important single thing in the diagnosis of organic heart disease. All but the more uncommon types lead to hypertrophy of the ventricle, particularly the left. Greatly enlarged hearts are, of course, easily recognized. The need is for differentiating hearts less abnormal, at a period when the advancing process may be controlled. The heart is more nearly related to the size of the body than any other organ except the brain. Living hearts, however, cannot be weighed. Recourse must then be had to the x-ray shadow, and the real problem has been to find if, in the normal individual, the dimensions of a heart silhouette can be predicted from any of the body measurements. My colleague, Dr. Eyster (7), in collaboration with Dr. P. C. Hodges and Dr. F. J. Hodges, has devoted considerable time to such studies. By using the formulæ for correlation criteria, they have found that prediction tables may be made for either cardiac area or transverse diameter, based on the age, weight, and height of individuals. The silhouette area, for example, equals $\text{Age} \times 0.0204 + \text{Stature} \times 0.8668 + \text{Weight} \times 0.337 - \text{constant } 63.8049$. From the standpoint of diagnoses, these tables have justified themselves, for, if the percentage variation of 100 normals from the prediction area be compared with the percentage variation of 100 cases of organic heart disease, it will be found that over 90 per cent of these fall outside the normal range. Determination of the cardiac area by the orthodiagram or teleoroentgenogram is thus a practical procedure in cardiac diagnosis. It is of interest to know that introduction into the formula of such factors as girth, area of the lateral plane, lateral diameters, or thoracic measurements have not increased its accuracy.

There is a common belief that athletes have enlarged hearts, but there has been no

sufficient study of the matter, so far as we are aware. Eyster (10) has now secured a large series of observations on Wisconsin athletes. The subjects include 83 men and 84 women, all of whom have had athletics throughout their high school course and during two or more years in college. On comparing the areas of this group with the distribution curve of 100 normals, there is no variation from the normal and, therefore, no evidence of hypertrophy. Even with extreme exertion, heart areas of bicycle riders do not usually show marked enlargement, the minute volume being taken care of by moderate dilatation and increased rate. Extreme dilatation of the heart from exercise is probably rare or even non-existent. In one case we were able to secure a film of a student who had collapsed while forcing himself on the stationary bicycle. Much to our surprise there was a smaller heart area than normal. What had happened was doubtless an acute splanchnic dilatation.

The pericardium may be mentioned in this connection since there is evidence that it protects the myocardium from too great dilatation. If x-ray films be taken of the dog's heart with an increasing venous pressure, it will be found that, with an effective pressure of about 15 cm., the heart no longer enlarges. If the pericardium now be slit, the heart at once distends another 20 per cent or more. The protective function of the pericardium under normal conditions would thus seem to be established.

Two things which might be expected to modify venous pressure and, therefore, the diastolic heart size are plethora and hemorrhage. The doctrine of plethora has played an old honorable rôle in medicine. All cardiac dilatations were once plethoric. Although blood volume studies have shown that excess of circulatory fluid is rather rare, we decided to produce it experimentally and to find its exact effect on heart size. Injections of 6 per cent acacia saline were made into the jugular of a dog and, after

the circulation might be expected to be adjusted to its new volume, x-ray films were taken. Much to our surprise we found that acacia solution could be added until the animal's blood volume had increased as much as 100 per cent without enlarging the heart shadow. A typical example was that of a dog weighing 8.2 kilos, which received 800 c.c. of fluid. The heart shadow, which had measured 46 at the beginning, actually measured 43.6 sq. cm. at the end of the injection. In some way, then, the heart is protected from too great an increase in blood volume, and enlargements due to plethora probably never occur. Further study showed that the excess fluid was actually stored in the venules and capillaries.

In regard to hemorrhage, it is obvious that, with loss of blood, the time must come when the fluid returning to the heart is so limited that diastolic size and output must decrease. The interesting question is how much fluid can be withdrawn before this occurs. In 21 animal experiments, we have found that blood equal to 2 per cent of the body weight could be withdrawn before the diastolic heart shadow decreased. Further study showed that the effective circulation was kept up, not only by the entrance of tissue fluids, but by the entrance of blood from the stagnant areas of the capillaries and venules. Bleeding in man has in recent years been practised only sparingly, and generally only in cases of an embarrassed right heart, in which it is a logical procedure. In the light of the experimental results, it must be sufficient to deplete some of the storage spaces before the heart can be relieved. Middleton and Eyster (11) have followed the heart size in man during venesection. Here, too, as in the experimental animal, blood equaling about 2 per cent of the body weight must be withdrawn before the right heart shows a decrease in its dilatation.

Cardiac tonus is another debatable point in

circulatory physiology. X-ray silhouettes show no change in heart size during vagal and accelerator stimulation, provided the venous pressure is held constant, which seems to prove that the heart muscle has no tonus under nerve control such as is found in skeletal muscle. Many conditions, however, may increase or lower the ability of the myocardium to withstand intracardiac pressure. A classic example is chloroform, which, even in light anesthesia, markedly reduces the ability of the heart to withstand dilatation.

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DISCUSSION

DR. FRED J. HODGES (Ann Arbor, Michigan): We have been particularly fortunate in having Prof. Meek with us, for in his paper he has shown clearly that accurate roentgen methods can yield information based upon sound physiologic facts. It is encouraging to know that the methods which we use are accepted by the physiologist as a valuable means of studying certain physiologic functions. He has shown us that the heart size bears a definite relationship to cardiac filling and emptying, and, further, that the methods which we use to determine heart size are fully as accu-

rate, if not more so, than the less direct methods used widely by clinicians. Furthermore, he has shown that roentgen methods compare favorably with older and more widely recognized laboratory methods of making such de-

terminations in animals. All of the procedures which he has described, with the exception of roentgen methods of determining minute volume, are already well known and can be used without difficulty.

THE CLINICAL VALUE OF ROENTGEN MEASUREMENTS OF HEART SIZE¹

By FRED J. HODGES, M.D., Professor of Roentgenology, University of Michigan,
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ROENTGEN studies of the heart have not, in the past, been looked upon by cardiologists as of any considerable value. To be sure, calcification of the pericardium, foreign bodies within the heart or immediately adjacent to it, gross aneurysmal dilatations of the aorta, dextrocardia, abnormal position of the heart, and gross enlargement have, for some time, been readily recognizable roentgenographically. However, casual observations by the roentgenologists to the effect that in certain cases film studies show an "aortic heart," in others a "mitral heart," etc., have not served to impress the cardiologist greatly. If, however, roentgenologists will report exact area and transverse diameter measurements under standard conditions, including heart rate at the moment of examination and perhaps arterial and venous blood pressure readings; if they will accompany their report with a true sized diagram of the heart in relation to normal landmarks, and will go so far as to compare the measurements thus obtained with predicted normal measurements for the individual in question, their efforts must soon be rewarded by the clinician's recognition of the real value of such assistance.

Numerous methods have been described by various workers for determining the size

of the human heart in terms of its various diameters, its area, and its relationship to chest diameter. Of these, perhaps the most widely used is the planimetric, in which a teleroentgenogram is made at a target-film distance of 2 meters. The frontal plane silhouette and the total transverse diameter value are measured from the right border at its widest point to the midline; the left border is measured at its widest point to the midline, and correction is made for inherent distortion.

Although this method has certain shortcomings, these may be easily overcome by the employment of the method known as orthodiascopy, by the addition of simple and inexpensive accessories to almost any stock fluoroscope. Orthodiascopic studies enable the examiner to combine fluoroscopic examination of the entire chest and the mediastinal structures in the various angles with careful measurements of the frontal plane silhouette. In addition, results are immediately obtainable without the delay occasioned by the processing of photographic films.

Orthodiascopy is a simple method of outlining opaque shadows in their true size without the distortion which always accompanies the x-ray projection of opaque bodies on a photographic film. This is accomplished by recording the position of the tube target

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when a previously determined fixed point in the x-ray beam coincides with various points along the contours of the shadow cast upon the screen. The resulting diagrams are always considerably smaller than the shadow of the opaque object as seen on the fluoroscopic screen, since the screen image produced by projection of a shadow of an opaque object lying in a beam of divergent rays is, of necessity, magnified. Magnification is overcome only when an extremely small portion of the beam, preferably at the center, is utilized.

The operator must learn to use his orthodiascope with reasonable dexterity before the diagrams which he produces will be sufficiently accurate to warrant serious interpretation. Dexterity is readily acquired and the operator can easily check his ability by repeatedly measuring opaque objects of known area and shape. Once a certain amount of skill has been developed, the procedure becomes quite simple and may be employed quickly and accurately. The dotted outline of the cardiac shadow is quickly filled in, giving the exact outline of the heart as seen in the projection. It requires but the work of a few moments to trace the outline with a planimeter, to measure the total transverse diameter, and to compare the figures thus obtained with the predicted normal for the individual in question as obtained from normal heart size tables which have been developed and published (1, 2). The cardiac outline, the level of the diaphragm, the midline of the thorax, and other landmarks can readily be located at the time of examination and incorporated in the final tracing. This tracing, with the area and transverse diameter figures, and the comparison with the normal tables, is then transferred to a piece of letter-size paper. Directly upon this paper the examiner can record a notation of any additional information obtained during the screen ex-

amination of the patient. Information should include observations of the width of the retrocardiac space, for narrowing of this space indicates enlargement of the heart in the anteroposterior diameter, usually serving as a further check of frontal plane measurements. Any worthwhile information concerning cardiac and vascular pulsations and the width, course, and length of the aorta may also be included.

P. C. Hodges and Eyster have shown that, if measured cardiac silhouette area exceeds predicted area by as much as 7 per cent, the chances are three to one that cardiac disease exists. Eyster (3) has further shown that a definite relationship exists between the degree of cardiac enlargement and the type of cardiac lesion present. This relationship he has illustrated with scatter curves, demonstrating the distribution of individual case measurements within various groups of lesions in relation to the predicted normal. Further analysis of these curves shows an average cardiac silhouette area, measured for 100 normal cases, 1 per cent below the average predicted area for the same group. In another group of cases, in which accidental systolic murmur constituted the only abnormal clinical finding, the average frontal plane area of measurement coincides exactly with the average normal prediction. In groups of cases known to have specific cardiac lesions the scatter above and below the average measurement is far greater than in the normal group, a fact best explained by the variable age of the lesions and the resultant variable time during which increase in heart size has taken place. Even so it has been possible to group cases fairly well by means of x-ray studies alone.

In reviewing the roentgen findings in a group of proved cases of cardiovascular syphilis, we have been able to show conclusively that no cardiac enlargement existed in several instances of undoubted aortic

aneurysm although cardiac enlargement was suspected by the clinician. Observations of this sort carry considerable weight, especially since they may be repeated on several occasions with but minor variations. Although, in simple mitral stenosis, cardiac area is not ordinarily increased until one or more periods of decompensation have ensued, with the resulting development of mitral insufficiency, orthodiagraphic studies yield pointed information concerning enlargement chiefly restricted to the left auricle. Thus it is possible in a considerable number of cases to recognize mitral stenosis by roentgen methods alone. We now decline to pass judgment in matters of heart size until an opportunity has been offered to permit of more detailed study, as has been described, for orthodiagraphic measurements frequently disprove cardiac enlargement suspected on routine chest examination.

In pericardial effusion, orthodiagraphic studies yield valuable information concerning heart size. The data are of service to the clinician in following the progress of a case, and when they are combined with orthodiagraphic studies and fluoroscopic examination of the heart with the patient lying first on one side and then on the other, they enable the observer to detect with rather great certainty pleuro-pericardial adhesions. It is of importance to recognize the existence of auricular fibrillation when one is making area measurements of the heart, for auricular fibrillation notoriously results in cardiac enlargement. It is of further interest to see the heart size decrease when the fibrillation ceases.

One case of traumatic femoral aneurysm, probably an arteriovenous aneurysm, was recently seen at the University of Michigan. The aneurysm resulted from a stab wound in the right groin below Poupart's ligament, when a short, sharp paring knife was stuck accidentally into the soft tissues at this point. The patient reports that a stream of blood

about an inch in diameter poured from the wound without noticeable pulsation, striking the floor about two and one-half feet in front of the patient. When he was seen at the University Hospital, about two months after the original accident, the patient presented, in the right groin, a swelling about the size of a lemon, in which distinct arterial pulsations could be detected and over which a marked systolic thrill could be palpated. When he was standing quietly, the pulse rate was counted at 108 per minute. The blood pressure, measured with a mercury monometer, was found to be systolic 152, diastolic 80. The pulmonic arch, as seen under the fluoroscope, was prominent; the pulsations here were of great amplitude.

The patient had learned that, by exerting digital pressure over the pulsating mass in his groin, he could alter his heart rate and completely obliterate the thrill described. When this was done, the pulse rate promptly dropped to 80-90, and the blood pressure was recorded at systolic 160, diastolic 98. When pressure was applied to the aneurysm during fluoroscopic examination, the prominence of the pulmonic arch was seen to disappear immediately as the amplitude of pulsation was greatly reduced. The frontal plane cardiac area, measured before the aneurysmal sac was obliterated, was 141 sq. cm., or 21.5 per cent above this patient's predicted normal. The transverse diameter figure was 137 mm., or 7.5 per cent above the predicted normal. Following the application of pressure to the aneurysmal sac, the drop in heart rate was found to be accompanied by a distinct increase in cardiac area, to 150 sq. cm., or 29.2 per cent above the normal predicted, while the transverse diameter increased to 142, or 11.4 per cent above the predicted normal.

These observations will serve to indicate the relatively small individual changes in heart size which can be recognized by the methods described. They also emphasize

the necessity for correlating other clinical observations with x-ray studies in order to explain variations which may be noted.

SUMMARY

Heart size measurements made by x-ray methods can be of great clinical importance if the measurements are accurate and if they are carefully interpreted in the light of other clinical findings. Casual statements as to heart size are in all probability of very little real value to the cardiologist. Since methods of accuracy are so readily available, there seems little justification for attempted

interpretation without employing them. Tables for the quick computation of normal area and transverse diameter measurements are available which make it possible for the roentgenologist to report directly the extent to which the heart in a given individual varies above or below his own individual normal.

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HYPODERMOLITHS

WITH REPORTS OF ONE LOCALIZED CASE AND ONE GENERALIZED CASE¹

By C. E. PIERSALL, M.D., RENO, NEVADA

CALCAREOUS deposits in and beneath the skin, which are variable in nature, may be divided into several groups and classifications. These reports and studies will not include: (a) the true osteomas of the skin, (b) phleboliths and calcified atheromas, (c) the secondarily calcified subcutaneous tumors (epitheliomas, fibromas, lupus, tuberculosis, and cysts), or (d) the calcified fat lobules on the inner side of the leg, which appear in the aged. The paper will deal with the fifth division of the group made by Broc and Darier, (e) calcareous subcutaneous concretions, or calcinosis, which is a rare entity. Although Köhler's "Roentgenology" says that not more than a dozen cases have been reported in the whole medical literature, apparently

fifty or more were recorded previous to the publication of his book; some of these reports, however, are brief or incomplete.

This group has been given various names: hypodermoliths, petrification of the skin, lime gout, calcareous subcutaneous concretions, calcinosis, granular deposition of lime, chalk gout, dermal and subdermal concretions, and gout stones.

In the sixteenth century, Trancavella, Ambroise Paré, and Fallopio referred to stony productions in the skin. Incomplete records were made by Richting, in 1834; Vogel, in 1843, and Auvers, in 1851. Wilckens, in 1858, made the first complete study of the subject. In 1900, Renon and Du-four made quantitative analyses in a series of cases of phosphated concretions. Similar studies were made the same year, and have been made since then. In 1911. Thi-

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bierge and Weissenbach studied the relation of calcareous deposits to sclerodermy, referring to eight cases. In 1925, Gilbert and Pollet surveyed the literature, classified the cases, and noted the difference in the two chemical varieties. Since then a few cases have been reported.

CLASSIFICATION

Histopathologically, these lime deposits, which have been called both granulomas and concrements, frequently seem to be produced at the site of sclerosed tissue which is in a state of hyalin or colloid degeneration. Sclerodermy and diffuse sclerosis of the connective tissues are often found together and are considered to have the same etiology. Similar processes are commonly found in the arterial walls and more rarely as plaques in the myocardium. Apparently, it is agreed that these deposits, and even those found in scleromyositis, are due to faulty calcium metabolism, yet local circulatory or tissue changes coincident with lowered vitality are probably, in some cases, preliminary to the calcification.

The classification may be summed up as follows:

1. Localized:
 - (a) Non-inflammatory.
 - (b) Inflammatory, which is secondary to pressure, trauma, or infection.
2. Generalized:
 - (a) Non-inflammatory.
 - (b) Inflammatory, which is secondary to pressure, trauma, or infection.
3. Phosphated calcium, total or predominant.
4. Carbonated calcium, total or predominant.

CLINICAL STUDY

Phosphated calcareous concrements are more frequently seen in the female sex.

Usually the deposit begins early in life, in the first, second, or third decades, sometimes as early as the first year of life, although one case was reported in a woman in her fifty-third year. The initial seat of the concrements is quite variable. It may be in the tips of the fingers, the legs, the anterior cubital region, the buttocks, the forearm, or the anterior region of the knees. The beginning is always insidious and indolent. Patients sometimes believe the deposits are caused by friction or pressure incident to certain occupations. One scrubwoman, who worked on her knees, developed hypodermololiths anterior to the patellas.

Hypodermololiths are trifling, often rent, tumefactions, which feign cold abscesses. The covering skin may be normal or thin and yellowish. The tumors gradually harden and enlarge, although some appear to be stony at the onset. While they are mobile on the deep planes of the skin, they are adherent and may even rupture the skin. They number from a single one to several hundred, and they vary considerably in size. In shape they vary from that of a grain of sand to that of a mulberry, with a mammillated appearance, or they may be large spheroid masses. In my generalized case (herewith reported) which presented phosphated and carbonated deposits, one accumulation in the right axilla is spherical, has a separated lower segment, feels like putty, and is about the size of a small orange. This is the largest deposit yet reported.

The localized form is rare, except in adults in whom the affection is usually confined to the fingers or to the scrotum, for, as a rule, hypodermololiths become general after several months or a few years. A degree of insensibility generally persists. Rarely and tardily there are quick shooting pains or repeated muscular cramps, aching in the fullest fingers, and tenderness to the touch. Rather frequently, when the deposits

are near a joint, stiffness may be noticed. Even trismus may occur, as in the case of Renon and Dufour. Amyotrophy, particularly of the deltoid, may be very prominent, and trophic and vasomotor disturbances of the skin are often observed (4).

The evolution of hypodermoliths is variable. Exceptionally they may heal through resorption or through spontaneous expulsion, but, as a rule, they will persist or reappear after ulceration. The skin which covers the tumors ordinarily becomes thin, livid, and perforated, while a creamy paste, similar to dilute chalk or tooth paste, yellowish or brownish in color, appears, which contains minute grains. Cicatrization usually rapidly follows elimination. Sometimes in the generalized cases there is fistulation or suppuration, followed by changes in the general state of health—fever, emaciation, albuminuria, and perhaps intense diarrhea—which, according to Profichet, are due to intestinal ulcerations as was found to be true in the only case of published autopsy.

Carbonated calcareous concretions are also more frequently seen in women, being usually found in the third, fourth, or fifth decades, although two cases were seen in little girls in whom the initial sites were at the extreme end of an upper limb, the forearm, hand, and fingers. The beginning is insidious as in the phosphated variety but functional disturbances are less pronounced. Almost always the carbonated type is associated with scleroderma, amyotrophy is rapid, and sometimes intense pains are felt, but the extension is less considerable and the general condition remains relatively good. Two cases, however, were reported which presented rapid ulcerations and cachexia.

Briefly, the differences in the two types may be summarized as follows:

Phosphated Type

Usually is seen in the first, second, or third decade.

Is of slower development and more prolonged pathologic course.

Is more generalized in form.

Carbonated Type

Usually is seen in the fourth, fifth, or sixth decade.

Less pronounced functional disturbances are present.

Often is localized in form.

Usually is associated with scleroderma.

PATHOGENESIS

Hypodermoliths do not represent a true lime gout as the blood is not overloaded with calcium when this lesion is present. Either a decomposition of soluble salts or a chemical combination with other substances produces the precipitation. The acid base equilibrium and the alkaline reserve were normal in the case reported by Weissenbach, Vignal, and Guillemin. Prof. Naegeli found the stools to contain a great quantity of calcium in a case associated with scleroderma, while in my generalized case it is decreased. The blood cholesterol is often increased but in my cases it is decreased. The basal metabolism increase from 20 to 45, in most general cases, brings in an element-in-figures indicating neuro-endocrine or at least endocrine involvement. Umber says precipitation may occur by common salt in the lime-containing healthy cells during production of lime metabolism or assimilation and pathologic retention may result. W. S. Shutze says that normal cells are free from lime because they produce carbon dioxide—the calcium carbonate and the phosphate going into solution—and that only when this production ceases would calcification set in. Umber and W. B. Schmidt believe this disease to be an assimilation disorder. Dr. Tashiro, a biochemist of the University of Cincinnati, says that calcium may be deposited by local production of ammonium or other base-forming compounds. Morse suspected a pancreatic change which

may have caused a lipolytic ferment because the subcutaneous fat was necrosed and located in and about the calcium deposits in the case which he reports of a three-and-one-half-year-old girl. This seems likely as his case showed atypical subdermal stones in atypical locations.

The mode of formation of these deposits is not understood. Unna believes the origin to be in the sudoriferous glands or in the adjacent subcutaneous tissues. Lewinski thinks it possible that they begin as limited lymphangiomas, while Derville can see no connection with the lymphatics. Milian and Profichet believe that there may be a special infectious disease and that probably there is a cutaneous coccidiosis which would account for some inflammatory cases. The hypothesis of a metabolic calcareous dyscrasia probably associated with thyroid, parathyroid, thymus, and nervous disturbances, would seem to explain the deposition of lime salts in a general way, whether the deposit begins in one cutaneous or subcutaneous structure or another. The metabolisms of phosphoric acid and calcium are intimately connected. Normally, the content of phosphorus in the blood serum is from 30 to 40 mg. per liter, being rather constant. The blood calcium is remarkably constant, being about 100 mg. per liter of plasma. The fixity of this blood calcium is determined by the regulating mechanism of the deposits and of the calcic excretion, which seems to be secured on one hand by the sympathetic or visceral nervous system, and on the other hand by the endocrine glands.

PATHOLOGY

In some cases there is no trace of inflammation, only soft or hard calcareous deposits are noted, located chiefly in the subcutaneous tissue, surrounded by a pseudocapsule formed of connective fibers. The stratum granulosum may present five or six

layers; the thickened stratum lucidum also shows visible uniting filaments. In the hypoderm the collagenous fibers are thin and drawn out (Weil and Weissmann-Netter). In the inflammatory variety a cut surface shows a convoluted appearance, the center showing a grainy, amorphous matter (Profichet), or a creamy softened contents which becomes chalky when dry. This substance is surrounded by a hull which contains mast cells, embryonic cells, and long connective cells. Surrounding it there may be dilated lymph spaces and enlarged capillaries, some of which are hyperplastic and even occluded. Adjacent oil or sweat glands may be distended or cystic, yet biopsies failed to show glandular tissue (25). Possibly the inflammatory changes may be found in any case after a certain degree of deposition has produced pressure and trauma or after infection has accidentally occurred following spontaneous or surgical drainage. Nageotte says the connective tissue changes are homogenization, hyalinization, fibrosis, and calcification.

DIAGNOSIS

In well developed cases, diagnosis may be made by physical examination and the history. Roentgen-ray examination, which alone is sufficient, shows little groups of sharply delimited, punctate, streaky, spheroid, or mammillated densities which are usually in and just beneath the skin, in isolated and usually irregular positions. The phalanges may be decalcified, but the joints are unaffected. Osseous sequestra, chronic hygromas, and secondarily calcified tumors should be differentiated by this method especially if a bit of history is correlated. Phleboliths in the abdomen or extremities, hemangiomas, calcified scars, thrombi, and hyaline masses cast similar shadows. Gouty tophi or uratic deposits have characteristic sites of predilection and they are much less dense than hypodermoliths, as we

note roentgenographically. One may exceptionally think of an atypical form of Recklinghausen's disease, or frequently of a scrotal atheroma. Remains of iodoform-glycerin injections, also iodipin and even dermatol, salvarsan, mercury, and bismuth preparations produce roentgenographic shadows. Rarely calcified trichinae and cysticerci may be seen in the muscles. In early cases of myositis ossificans definite shadows appear symmetrically on both sides of the body, being usually associated with macrodactylia. Chemical examination of the deposits may serve to differentiate in doubtful cases.

TREATMENT

In localized types or local areas, surgical drainage or ablation provides relief from the ache which may be considerable in the much affected parts, especially the finger tips. If the blood calcium or phosphoric acid is high, the diet should be chiefly meat to avoid calcium-rich food. A number of reported cases exhibited hyperthyroidism and one hypothyroidism. The good effects of treatment with various opotherapeutic medication justify us in this form of therapy. Since adrenalin lessens calcemia, but, in turn, increases phosphatemia, it cannot be considered useful, except perhaps in the carbonated variety. C. H. Rabl used ammonium chloride internally to decalcify artificially the bones for the purpose of reducing malformations; but from this (Rabl's) method of decalcification one would not expect much benefit because of the attending poor local circulation and because of the fibrous hull about the hypodermoliths. Also the process of decalcification might produce greater deposition in the superficial tissues, as was found after bone resorption in a case of infection of the metacarpals (11).

Acetylcholine has apparently cleared up more sclerodermas than any other remedy.

Naegeli lowered the amount of calcium in the blood with a parathyroid preparation, parathormone (Collip), and it seemed to lead to improvement in some cases which had not responded to pluriglandular, ovarian, or thyroid extracts. Ducasse found cholesterol in the concretions; he also found an abnormal amount in the blood, which he combated by reducing the fats in the diet, with apparent cessation of the deposition. Likewise the calcemia and phosphatemia may be decreased by limiting the vegetable and milk rations. He also found that radium liquefied the deposits and caused them to be expelled. Poultices, wet dressings, or soaking in soap solution for from twelve hours to several days has likewise caused softening and drainage. Fair results may be obtained with iodides. General eliminative measures should be instituted. My generalized case is being given X-ray treatments to the thyroid and poultices to the fingers. The localized case is having the hypodermoliths removed surgically one at a time.

REPORT OF CASES

Generalized Type.—Case 1. Mrs. T. L. H., age 58 years, was referred by James Thom, M.D., for X-ray examination of the fingers. Unusual shadows were seen by several roentgenologists, but were first recognized by Dr. Leaf, Associate Roentgenologist at Stanford University Hospital.

Family History.—The patient was the ninth child in a family of six girls and three boys. The father died at the age of 40 years of stomach trouble; the mother died at the age of 65 years of an unknown cause. One brother died of stomach trouble and one sister died at the age of 60 years of leakage of the heart.

Personal History.—The patient, who gives her occupation as that of housewife, was born in Ireland, and lived there for fifteen years. From the ages of 15 to 27

years (1886 to 1908) the patient lived in Colorado; from 1908 to 1930 in Nevada. She is of blond complexion. Her maximum weight was 122 pounds, at the age of 18.

Catamenia.—Puberty was attained at 12 years of age, and the menopause at 47, 11 years previous to examination.

Previous Illnesses.—The patient had had diphtheria in 1889, resulting in left partial paralysis of the vocal cords. Her voice has been weak since. In 1923 she began noticing lumps in the buttocks. Those just anterior to each ischial tuberosity were removed and sent to a pathologist who, however, did not classify them. The left hip began to be painful in 1924, and the next year the right wrist and the hands were swollen for three or four weeks. In 1927 the woman had erysipelas of the face in an aggravated form. In 1929 the skin covering the deposits in the left greater trochanter region opened and drained, for one year. At this time the patient was ill, remaining in bed for three or four weeks, with a temperature of 103° F. Nasal discharge and catarrh had been present from the year 1908. Venereal disease was denied.

Present Illness.—The first manifestations of the present illness were lumps in the buttocks. The finger tips are enlarged and some are scarred, sensitive, and painful. The patient feels nervous, toxic, and stiff.

Habits.—Coffee, 2 cups per day; no alcohol, no tobacco, no drugs. Patient is constipated.

Physical Examination.—Eyes—negative, but the patient is myopic and uses glasses for reading. Ears—normal except at times a feeling of fullness in the left ear and the nostrils. Fullness is felt in the drums and canal at times. There is a small chalky deposit on the rim of the right ear. The woman suffered from dizzy spells for a few months previous to examination. Nose—considerable watery discharge is present and there is post-nasal drainage, causing cough.

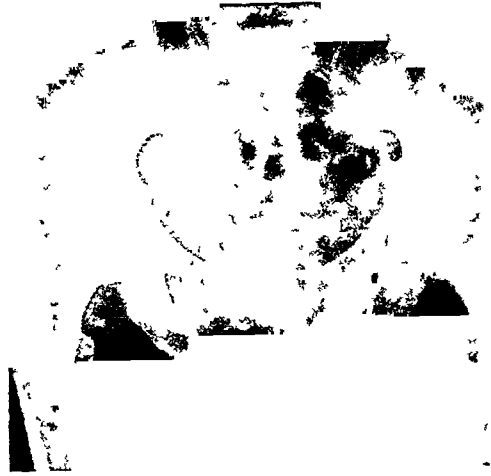


Fig 1 Hypodermolths near trochanter and ischial tuberosities, also plaques in skin above left buttock



Fig 2 Soft and hard deposits at tips of thumbs and all fingers; note osteoporosity

There is a large perforation of the septum, with black scales on its margin. The left nostril has lessened air space. Teeth—complete lower plate and partial upper; remaining teeth normal. Extractions were done in 1925. Appetite—good. Genito-urinary system—nocturia two or three times if fluids are taken with evening meal; no blood; no pus or retention. The last menstrual period was in 1918, at 46 years of age. Height, 5 feet, 3 inches. Weight, 96 pounds, deducting clothing. The woman is of the slender, thin-faced type. Large veins are seen in both the thighs and legs; puffiness is present distal to each external malleolus.

olus; movable hypodermoliths are present at the inner side of the left knee. There are scars of operation on each buttock and four scars about the left trochanter. There



Fig. 3 Photograph of hands; note enlargement of finger tips.



Fig. 4 Photomicrograph through skin, showing calcium deposits (low power).

are plaques under the skin to the right of the right iliac crest. Putty-like deposits are present beneath the skin posterior to the left sacro-iliac joint. The patient's hair has been gray since the age of 40 (her mother was gray at about 50 years). There is a normal amount of hair on the body. The skin is rather dry and atrophic and the woman has not perspired since the year 1923, when she first noticed concretions in the buttocks. Muscles—negative. Tonsils—small. Heart—apex impulse in the fifth

interspace; no thrill. Arteries—sclerosis of femorals found by X-ray examination. Radials and axillaries—negative. Blood pressure: 184 systolic; 108 diastolic. Abdomen—negative. Extremities—joints are mobile, with lower bilateral varicosities of pronounced degree. Thumbs and fingers—full at and near ends on palmar aspect, with a few scars of puncture and sinuses. At the margin of one nail and on one finger tip are small yellowish-white deposits beneath the epidermis. The palmar part of the right thumb is about double in size, compressible, but tender. The other fingers are more firm. The skin adheres to the masses. Color is normal when warm, purplish when cool, and white when cold.

Personal Impressions.—The patient thinks the condition is caused by intestinal toxemia, as she feels well only after a cathartic has acted. Enemas cause pain low in the middle of the abdomen.

Reflexes.—Patellar, triceps, biceps, and Achilles—negative. Wrists—present, equal, and active. Abdominal—negative. There is neither knee nor ankle clonus. Babinski's reflex, Oppenheim, and Romberg signs—negative.

Röntgen Findings.—These are shown in the reproductions of films and their accompanying legends. In addition, there are subcutaneous concretions on either side of both knees, particularly on the inner side of the left knee joint, and on the upper leg: calcifications in varicose veins of the legs and thighs, of the costo-vertebral cartilages, and the tips of the transverse processes of the lumbar vertebrae. One toe contains a large deposit at its tip.

*Pathologic and Clinical Laboratory Examinations.*²—Urine—normal, except for diminished phosphates and a few squamous epithelial cells. Feces—normal. No abnormal cells, bacteria, or parasites; no bile or blood is present. Basal metabolic rate

²Made by Arthur L. Grover, M.D., Reno, Nevada.

—plus 24. Blood count—hemoglobin, 90 per cent; color index, 0.9; clotting time, 3 minutes, 25 seconds; red blood cells, 4,600,000; white blood cells, 8,200; polymorphonuclears, 63 per cent; lymphocytes, 25 per cent; large lymphocytes, 1 per cent. Considerable achromia is present.

Chemical Blood Examination

		Normal
Blood sugar (dextrose)	147.06 mg. per 100 c.c.	85 to 110
Creatinine	2.86 mg. per 100 c.c.	1 to 2
Uric acid	3.09 mg. per 100 c.c.	2 to 3
Non-protein nitrogen	40.28 mg. per 100 c.c.	25 to 30
Urea	41.92 mg. per 100 c.c.	10 to 15

The bilirubin was shown by the Van den Bergh test to be diminished.

Biopsy.—A section of the palmar region of the right thumb, $3.5 \times 1.5 \times 1$ cm., was taken for biopsy. The flat, or cut, surface showed a hard, firm mass of tissue full of more or less fused, white, calcified areas. Microscopically, there was a normal appearing epidermis beneath which the dermis showed dense and fibrosed. The blood supply seemed to be subnormal. The few blood vessels present appeared to have hyperplastic walls, due to an increase in the amount of fibrosis, particularly of the endothelium. There were numerous, somewhat dilated, capillaries and lymph spaces scattered throughout. In several places there seemed to be collections of lymph cells undergoing a marked fibrosis which may have been the remains of lymph nodes. Some of the cells in these had taken up calcium and retained it, while in other places there were marked deposits. In all of these places the salt appeared to have been first deposited in the endothelial cells about the blood or lymph spaces. From these locations the material was deposited in rather large masses; by the fusing of these, still larger masses have been formed until the appearance of larger dermoliths was obtained, as shown by gross examination. These act as any foreign body, stimulating the surrounding connective tissue to hyperplasia, so that the de-

posits become fairly well walled off. By the resulting pressure rather compact calculi have been formed, which may be shelled out.

Biologic Examination³

Blood Serum (Untreated)

		Normal
Calcium* (as Ca).....	13.2 mg. per 100 c.c.	9 to 11
Phosphorus** (as P) ..	4.9 mg. per 100 c.c.	3 to 4

Blood (Oxalated)

Cholesterol†	115.0 mg. per 100 c.c.	150 to 190
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Deposit

Microscopic appearance — white, non-crystalline masses	
Cholesterol‡	present
Total weight of sample.....	7.7 mg.
Residue after washing.....	5.3 mg.
Ash on sample.....	68.84 per cent
Ash constituents	
Calcium* (as Ca).....	39.81 per cent
Phosphorus** (as P).....	16.03 per cent
Carbonates	present
Hypothetic combinations in ash	
Ca ₃ (PO ₄) ₂	80.15 per cent
CaCO ₃	21.97 per cent
Stool	
Ash, on moisture-free sample.....	10.61 per cent
Ash constituents	
Calcium†† (as Ca).....	2.17 per cent
Phosphorus‡‡ (as P ₂ O ₅).....	37.76 per cent

Localized Hypodermoliths. — Case 2.

This condition was discovered incidentally by inspection, when the patient submitted himself to me for galvanic therapy for pruritus ani, hemorrhoids, fissure *in ano*, and for ultra-violet radiation for tinea vesicolor. Upon recognizing this as a localized case of hypodermoliths, I made roentgenographic examinations of the extremities, pelvis, and abdomen but found no evidence of calcareous deposits, except those in the scrotum.

Family History.—The parents are living and in good health. Six brothers and three sisters are also living and well.

³Made by M. R. Miller, Chemist at the University of Nevada.

*Determined by Clark and Collip modification of Kramer-Tisdall method. Jour. Biol. Chem., March, 1925, LXIII, 461-464.

**Determined by Fiske and Subbarow modification of Bell-Doisey method. Jour. Biol. Chem., 1925, LXVI, 375-400.

†Determined by method of Meyers and Wardell modified. Hawk and Bergeim, Practical Physiological Chemistry. P. Blakiston's Son and Co., Philadelphia, ninth edition, 391, 392.

‡Meyers and Wardell: Jour. Biol. Chem., 1918, XXXVI, 147.

§Qualitative test for cholesterol by Liebermann-Burchard reaction.

††Determined by McCrudden's method. Jour. Biol. Chem., 1910, VII, 83. Also 1911, X, 187.

‡‡Determined by uranium acetate titration.

Personal History.—The patient who is 41 years of age weighs 195 pounds, is of blond complexion and has blue eyes. He had pneumonia at the age of 12 years and influenza several times prior to 1914. He has



Fig. 5. Case 2. Photograph of scrotum, showing skin stretched.

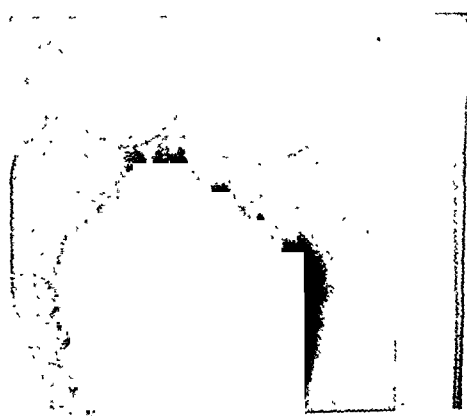


Fig. 6. Case 2. Localized case, showing few of stones in scrotum.

skin. They could be enucleated, sac and all, by slitting the overlying skin. The physical examination was otherwise negative.

Habits.—Coffee, about one cup per day; no alcohol, no drugs. The patient has smoked a pipe and cigars for the past five years. He partakes of a mixed diet; is slightly constipated but has one or more stools daily, absolutely at will. He perspires freely.

Laboratory Examination.—The urine examination was negative except that the specific gravity was 1.022. The chemical blood examination was normal. The Wassermann test was negative.

Biologic Examination

Blood Serum (Untreated)

Calcium (as Ca).....	10.4 mg. per 100 c.c.
Phosphorus (as P).....	4.47 mg. per 100 c.c.

Blood (Oxalated)

Cholesterol	126.7 mg. per 100 c.c.
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Deposit

Microscopic appearance—white, partly crystalline masses, but indistinct

Macroscopic appearance—a white, hard mass in an envelope of thin tissue

Weight of sample.....0.4272 gm.

Weight of sample, dried.....0.4154 gm.

Organic matter.....present

On ignition of dry sample.....15.44 per cent

Calcium*** (as Ca) on dry sample.....33.05 per cent

Phosphorus (as P) on dry sample.....10.30 per cent

Cholesterol on dry sample.....0.28 per cent

Hypothetic constituents of dry sample:

Calcium carbonate (CaCO_3).....32.74 per cent

Calcium phosphate ($\text{Ca}_3(\text{PO}_4)_2$).....51.48 per cent

Organic matter.....15.44 per cent

REMARKS

In my generalized case both the skin and bowels are quite under-active, the patient never feels well except after a cathartic has acted, and she has not perspired since the first signs of the deposits, which were found in the lower part of the buttocks in 1923. As the urine examination was normal, the increased end-products found in the blood indicate poor skin function. Her blood calcium and phosphorus are a little high, while the cholesterol, as in the localized case, is low. The stool contains a decreased amount

***The methods used are as given in Case 1.

lived in the southern part of the United States most of his life.

Present Condition.—About the age of puberty this man began to have small pustules, simulating acne, on the scrotum. He kept them empty for some time by evacuating them, but for several years he had left them alone, until at examination they presented the appearance of calcified, hard, white, oval, cystic masses just beneath the

of calcium, but the normal amount of phosphorus. While Gilbert and Pollet say that cholesterol is never found in the deposits, it is found in both the generalized and the localized cases cited here and it was also reported in one other, Ducasse's case. In the

pressure was 150 S. and 90 D. as compared with 184 S. and 108 D. before treatment. Her weight had increased from 96 pounds to 109½ pounds, and she was no longer nervous.

On Aug. 22, 1932, her weight was 119



Fig. 7. Case 1. Large putty-like mass in axilla (it had not been noticed by patient).

localized case, the blood calcium and phosphorus, and the composition of the deposits, are similar to those of the generalized case. Both belong to the phosphated variety. The generalized case is one of the oldest of these patients on record. She has the largest deposit reported and is the only case I have found in which all fingers and both thumbs are involved.

ADDENDA

Progress of Cases.—No treatment was given the localized case.

We administered to the generalized case the following roentgen treatments:

Nov. 20, 1930: 1 E.D. to the entire thyroid gland.

Feb. 19, 1931: 1 E.D., as before.

March 19, 1931: ½ E.D., as before.

On April 30, 1931, the patient's blood

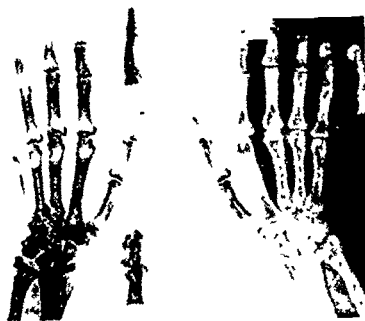


Fig. 8. Reproduction of Busi's case.

pounds, there was no nervousness or discomfort, and the calcific deposits were apparently unchanged, indicating that the process of calcinosis had ceased. The improvement in the general health is accounted for by the reduced activity of the thyroid and coincidentally the parathyroid glands, as a result of roentgen radiation.

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AN X-RAY SIGN IN THE DIAGNOSIS OF REDUCIBLE ESOPHAGEAL ORIFICE HERNIA¹

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THERE has been an increasing interest in diaphragmatic hernias during the past few years. This is due, in part, to the fact that the clinical manifestations of the condition are manifold, often simulating and being mistaken for other, and usually more serious, intra-abdominal conditions. There is also a growing suspicion among some clinicians that diaphragmatic hernias may sometimes cause a severe, obscure anemia. The literature has now assumed siz-

able proportions. The clinical, developmental, and roentgen features have been well considered at length.

Most of the recent observers stress the point that diaphragmatic hernias, particularly those through the hiatus, are still being overlooked in spite of the wide use of x-ray methods. These authors also call attention to the importance of a thorough examination in the various horizontal positions, if this condition is suspected. Owing to the limitations of time, space, and apparatus, many small laboratories, and not a

¹Read before the Radiological Society of North America, at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

few of the larger clinics, do not make such studies routinely. Moreover, some diaphragmatic hernias, even in the horizontal position, can be demonstrated only by prolonged and repeated examination. The importance of the lesion does not warrant making such a long-drawn-out routine search with all gastro-intestinal cases in a busy clinic. Any sign in the vertical position calling attention to the possibility of a diaphragmatic hernia should be of value.

Gray, discussing the comprehensive article of Ritvo, suggested that it is absolutely impossible to diagnose or even suspect reducible orifice hernias with the patient in the vertical position. This is the type most apt to be overlooked during the roentgen examination, at the operating table, and even during the postmortem.

The esophagus in the lower third forsakes its close relation with the spine, curving laterally and forward to pass through the hiatus esophagi of the diaphragm, and thence to reach the stomach at a rather acute angle. This portion of the esophagus is normally capable of respiratory motion, traveling to the midline and forward on inspiration. The stomach, which hugs the medial half of the diaphragm closely, is in an excellent position to herniate, if there be an opportunity to do so

The stomach migrates downward, as does the diaphragm, and the esophagus lengthens to permit this descent. Failure of the esophagus to do so for any reason causes a portion of the stomach to extend through the diaphragm. This hernia, known as the short esophagus type, has been well described by Akerlund and Anderson. If the patient assumes an upright position, there is no opportunity for a reduction. This hernia is excessively rare and has identifying characteristics of its own. The diaphragm originates to a large extent in the septum transversum, originally a cervical structure, the sternal portion of which gives rise to the



Fig 1. This radiograph of a small, reducible, esophageal hiatus hernia was made in a horizontal position. The line indicates the course taken by the barium as it ran into the stomach. Although when the patient was in the upright position the hernia reduced, the same curve was present if the patient swallowed the barium on full inspiration.

pars costalis and sternalis of the diaphragm, while the dorsal portion gives rise to the pars vertebralis of the diaphragm. The hiatus esophagi is formed as a space between two muscle bundles, or groups, of the diaphragm arising from the spine. Lack of or imperfect development of these muscles gives an opportunity for herniation to occur, which in our experience has consisted only of the stomach.

A perusal of the literature and a study of these cases will show that redundancy and abnormal mobility of the esophagus are not uncommon. As the stomach herniates through the hiatus, one of two things probably happens: the involved portion of the stomach may pull the end of the esophagus

along with it sufficiently to make an upward curve, or there may be a direct pressure against the esophagus, causing the redundant portion to buckle and thus describe a curve. This obviously cannot happen with hernia of the short esophagus type, and there is absence of the sign to be described below.

In the erect position, the esophagus and stomach may appear perfectly normal. In such instances, it is often possible, by increasing the intra-abdominal pressure sufficiently, to cause the end of the esophagus to angulate, even though not sufficiently to cause a gas bubble to appear above the diaphragm. Much less frequently we may see abnormal areas of narrowing and hesitation, sometimes with a slight dilation of the esophagus above. Camp has noted a lateral displacement of the esophagus. When present, such findings are an aid in the diagnosis. Intimate knowledge of the normal anatomy of this region is quite essential for the appreciation of these changes.

It is necessary to observe a definite technique. The patient is placed in the vertical right anterior oblique position, the central ray being directed through the gastro-esophageal region, using as small a diaphragm as possible. The ordinary stomach barium mixture is employed. Heavy, thick esophageal suspensions must not be used. The patient is told to take a mouthful of the barium mixture without swallowing and then instructed to inhale deeply through the nose, the head being bent slightly forward. While the breath is held in full inspiration, the patient is told to swallow. In the meanwhile the examiner's right hand is pushed firmly against the anterior abdominal wall. The left diaphragm is watched carefully to see that the patient does not expire ever so slightly as there is some tendency to do on deglutition. Partial expiration will in most cases not suffice to cause distortion of the esophagus. The amount of pressure applied with the hand varies according to the

tone of the abdominal muscles, being greater if the latter are soft and flabby. Close attention must be paid to the head of the barium column as it descends. If a hernia is present, the barium stream usually takes an upward course as it is about to enter the stomach. This may be a sustained direction or merely a transitory flip, occurring only when the head of the barium column reaches the region. For obvious reasons, it is difficult to secure an adequate roentgenographic delineation of the movement. The observation is essentially a radioscopic one.

If alteration of the stream is noted, careful horizontal studies in all positions should be made and repeated two or three times, before one may conclude that no hernia exists.

CONCLUSIONS

1. An x-ray sign in the diagnosis of reducible esophageal orifice hernias, depending on the distortion of the esophagus by increased intra-abdominal pressure, is described.
2. A simple routine procedure is outlined whereby the sign may be elicited during vertical radioscopy.
3. The necessity for intimate familiarity with the normal anatomy of the gastro-esophageal region is stressed.

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A ROENTGEN CONSIDERATION OF COMMON CONGENITAL ANOMALIES AS RELATED TO INJURIES

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DEFORMITIES may be congenital in origin or the result of trauma, static conditions, muscular contractures, muscular weakness, atrophy, or paralysis. It is impossible to illustrate all of the congenital conditions that could occur in bones and joints; however, some of the most common ones are very frequently mistaken for injuries and are, therefore, worthy of consideration.

Congenital anomalies are thought to be signs of lowered resistance. This is further proven by a complete check-up of our patients in whom we invariably discover other defects co-existing in bones and joints. Beginning with the vertebral canal, we occasionally see that the coalescence of the laminae is incomplete. This results in a cleft being formed in the posterior arch of a vertebra with a consequent protrusion of the dura and arachnoid, if the cleft is wide. Spina bifida may be a final outcome. This condition may be so extensive as to involve the posterior arches of all the vertebrae, resulting in an incomplete vertebral canal.

From the orthopedic viewpoint, spina bifida is of interest because of the muscular weakness and deformity of the spine, which may end in a postural curve or extensive scoliosis, with bony changes. Together with the above conditions, we may find such associated conditions as club feet or deformed hips. Complete or partial absence of bones may also exist. Some cases of spina bifida show only a few of the above deformities, whereas in others they are all present. Spina bifida seems to be most common in the lumbosacral and sacral regions (Fig. 1). One not acquainted with this condition may often read fracture in a patient complaining of low-back pain. Awards are frequently given, erroneously, to injured patients be-

cause of inability to recognize this condition. There may be an absence of fusion of the laminae or variations in the articular facets. Another common anomaly is the slight upward tilting and narrowing of the transverse process of one or the other side.



Fig 1 Spina bifida (congenital) may be mistaken for fracture by one not acquainted with this condition.

which may be further accentuated by the psoas muscle passing over the transverse process, giving the appearance of a fissure fracture. This anomalous condition is very important from a medico-legal standpoint, as it is often mistaken for an injury.

In the cervical region, a frequent anomalous condition is noted. Early in fetal life, the anterior, or costal, part of the transverse process of the seventh cervical vertebra is

sometimes ossified from a separate center. Union occurs with the body and posterior part of the transverse process about the sixth year. If the costal part persists as a separate piece, it lengthens and becomes a

vein. One can readily see that slight injury on the arm of a patient may cause a great deal of obscure pain unless "cervical rib" could be ruled out

Congenital absence of ribs is not uncommon



Fig 2 Congenital absence of the radius

"cervical rib" with a definite head, neck, and tubercle, extending antero-laterally into the posterior triangle of the neck. It may terminate freely or join the first thoracic rib. Cervical ribs are clinically, as well as roentgenologically, important as they give rise to vague nervous and vascular symptoms, depending on their approximation to the brachial plexus or subclavian artery or

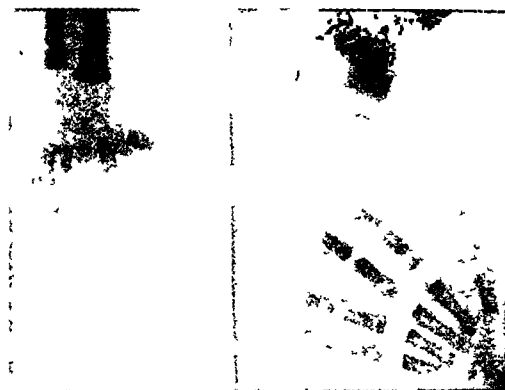


Fig 3 Undeveloped metacarpals with resulting absence of phalanges

mon and when it exists there is usually an asymmetry of the thorax. This may also lead to deformities of the spine.

The transverse process of the first lumbar vertebra is sometimes developed as a separate piece which may remain permanently un-united with the rest of the bone, forming a lumbar rib.

The fifth lumbar vertebra has always been a great source of controversy. Many thousands of dollars are paid by companies carrying compensation for supposed injuries to this vertebra as well as for sacro-iliac strain. Many anomalous conditions occur in this bone. It may be bifid, thus causing improper ligamentous attachments, resulting in weakness and low-back pains. One transverse process may be larger than the other, causing sacralization of either one or both sides.

It is rare to find injuries in the fifth lumbar vertebra, because its massive construction and its position inhibit the occurrence of lesions here. It is surrounded by muscles and ligaments and protected on either side by the ilia. Because the transverse processes

are in close approximation with the iliac bones and, due to the abutment of the transverse process against the ilium, one can readily see that a sudden turning or bending will result in a severe sprain or fracture.

remarkable variations from the normal. Congenital absence of the radius or ulna is not uncommon (Fig. 2).

Total or partial absence of the long bones of the body may exist. In some instances,



Fig. 4. Supernumerary digits.

One can appreciate the precarious position of the fifth lumbar vertebra, placed as it is between the mobile spine superiorly and the immobile sacrum inferiorly.

A malingerer who once has suffered from a genuine injury to the spine may present himself. He may have fully recovered from the injury, and he may realize this fact. Although the effects have in reality disappeared, he may have developed a neurosis which leads him to believe that he is still suffering from these effects. The physician may have some difficulty in determining if the patient has any justification for his complaint of continued disability. There are other malingerers, of course, who claim bad effects from an injury which never took place. Many tests for malingerers are known and used.

Several deformities of the upper extremities are met with. One arm may be represented by a small atrophied structure which may have the bones complete or may show

only the epiphyseal line, or growing portion of the bone, is affected, without any apparent absence of the bone. The structures of the leg or arm, therefore, do not grow as they should and as a result deformities of the hand or leg are present. When the humerus or femur is defective the bones are usually deformed. When the bones below are present, there is usually some small bone corresponding to the absent one. If any of the tarsal or carpal bones is absent, the metacarpal or metatarsal bones beyond it are apt to be missing (Fig. 3).

The wrist and hand may be represented by a small fleshy mass with a number of partly ossified bones in its interior, and supernumerary digits may also exist (Fig. 4), which may be unilateral or bilateral.

Very often in cases of injury the astragalus is reported to be fractured when in reality the os trigonum, a common congenital anomaly in the foot, is seen. This is nothing more than a backward extension for a vari-



Fig. 5. Congenital dislocation of hip before reduction.

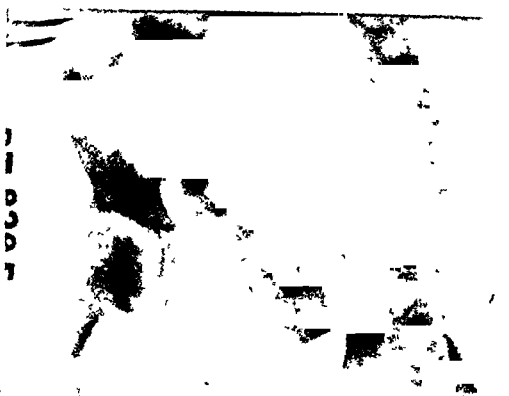


Fig. 6. Reduced congenital hip dislocation.

able length with failure of union. Because of its smooth and even edge, some anomalous condition is usually thought of.

A most frequent congenital deformity is congenital hip dislocation, which may involve one or both hips, and seems to predominate in females. In 801 cases reported by Whitman,¹ 655 were in females and 146 in males. These dislocations are oftentimes submitted in evidence as traumatic and may usually be passed as such if the case is not studied properly. In this condition, the hip may be very slightly dislocated, the femoral

head sliding insecurely in the acetabulum, or it may be so markedly dislocated that the trochanter approximates the iliac crests. When the child begins to walk, there is usually a noticeable limp which gradually increases, seeming to be more apparent in a single than in a double congenital dislocation. The trochanters often ride high above Nélaton's line and there is also a shortening of the affected leg. Early in this condition, the capsule allows great freedom of motion. However, as growth progresses, the capsule becomes shorter and limitation is restricted due to the inelasticity of its fibers; the cotyloid ring also becomes narrowed, making reduction somewhat difficult, and, because of the muscular imbalance, lordosis becomes extreme (Figs. 5 and 6).

A common deformity that the roentgenologist, as well as the orthopedist, meets with is a congenital elevation of the scapula (Sprengel's deformity), involving one or both bones. Many lawsuits have been won and much compensation awarded because of the failure to diagnose this condition. The scapula is elevated and inclined slightly forward and outward, being less movable than normally because of the shortening of the muscles that attach it to the spine or ribs. This high position of the scapula causes a deformity of the neck as well as scoliosis.

Several anomalous conditions are found

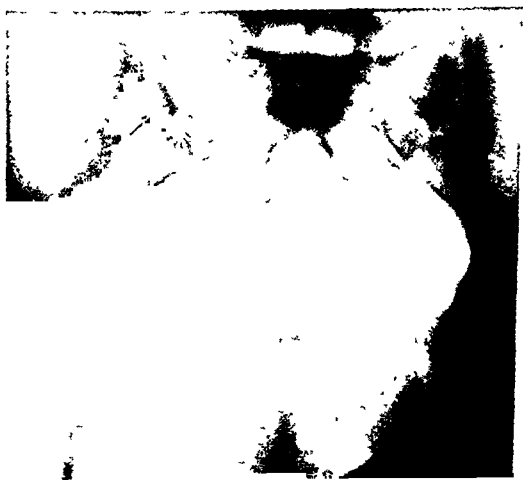


Fig. 7. Delay in ossification of the postero-superior iliac spine and dorsal third of the right iliac crest

¹Whitman: Orthopedic Surgery. Eighth ed., page 831.

in the ossification of the pelvic bones. Besides the three primary centers of ossification present in each hip bone, several secondary centers exist. These secondary centers appear about the age of puberty and, unless their site of appearance is well known, a mistaken diagnosis of fracture will often ensue. Delay in ossification of one of these secondary centers may also simulate fracture (Fig. 7).

CONCLUSIONS

The importance of roentgenograms as an aid to traumatic conditions cannot be emphasized too strongly because of the relationship they bear to the legal aspects of the case. Roentgenograms become invaluable

in cases of disputed diagnosis. It is further essential that every X-ray film taken for testimony should show good bone and soft-tissue detail. Physicians very often testify to certain findings in a film that is poorly taken and improperly developed. This often leads to serious consequences involving the patient and also the professional standing of the physician. It goes without saying that physicians offering X-ray testimony should be well able to differentiate between normal, pathologic, and congenital abnormalities existing in the human anatomy. It, therefore, behooves the roentgenologist to consider carefully the possibility of congenital anomalies existing in the anatomic make-up and to bear in mind the relation of injury to these foci of weakened resistance.

ROENTGENOLOGIC EXAMINATION OF THE NASAL ACCESSORY SINUSES IN INFANTS AND CHILDREN¹

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IN the newborn, one sees well formed maxillary sinuses and a varying number of ethmoid cells. Seldom are the frontal and sphenoid sinuses materially developed at birth, or in early infancy. During infancy and early childhood, one sees the early development of the frontal sinuses into the vertical and horizontal plates of the frontal bone, from the ethmoid cells. The sphenoids are also noted then, developing first in the anterior part of the body of the sphenoid bone. One expects to see well developed frontal sinuses at the age of four or five years, and a well developed sphenoid at a slightly later age. The presence of an infection in the ethmoid cells and the maxillary sinuses may materially retard the development of the frontal and sphenoid sinuses. A certain percentage of adults have

no frontal sinus development into the vertical plate, while others have only one frontal sinus. There are many variations in size, shape, and position of the sinuses, calling for individual interpretation in most instances.

In infants and children, there are technical difficulties in the roentgenologic examination of the sinuses which necessitate a modification in routine adult technic. Nowhere are patience and painstaking attention to detail more richly rewarded than in this type of roentgenography. The confidence of the child must be obtained if we are to obtain roentgenograms of maximum value. I need not stress the necessity, in many instances, of separating the child from its over-anxious parents before its confidence can be obtained and its fears allayed.

With infants, one must be content with

¹Read by title before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

roentgenograms in the postero-anterior and lateral projections. Rapid technic is possible with modern equipment, and, in most instances, satisfactory diagnostic roentgenograms can be obtained. If the head is held firmly by a nurse or assistant, one can often obtain a good roentgenogram even if the patient is crying. The x-ray switch must be controlled, and the exposure made by someone who can observe every motion of the infant, and who is thereby able to determine the proper time for making the exposure. It is very difficult to obtain satisfactory roentgenograms if the exposure is controlled from some distance behind a screen. I know that this is contrary to the usual principles of safety to the operator, but, if one wishes to obtain roentgenograms of good quality, the exposure must be controlled from a point close to the patient.

With children who are able to co-operate, and generally this includes children of three years or more, the adult technic can usually be followed in detail. Films are made without the use of the Bucky diaphragm. No special apparatus is used other than that found in any well equipped laboratory. A small cone, 11 inches in length, is used, with a 2.75-inch aperture. Cone pressure against the head is used for immobilization. This gives an average target-head distance of 16 inches. With all exposures, 1 mm. filter is used between the tube and the patient. The cone is carefully leveled before each exposure. If no special apparatus is used to hold the head, this detail is important. Cross-lines etched on the face of the cassette facilitate accurate centering of patient and cone on the film. The use of a small-aperture long cone, covering just the area to be examined, gives excellent detail and contrast. The head is placed directly on the cassette. I believe this is also important as it permits a minimum distance between the part to be examined and the film. Secondary radiation is prevented by the use of the small cone. Immobilization by cone pressure, or by a

towel held firmly across the head by an assistant, is, in my hands, superior to other methods of holding the head.

Four, five, or six exposures are made of the sinuses. In adults, five exposures are routinely made on two 10×12 films. Two exposures are made on the first film, and three exposures on the second. On the upper half of the first film is made an exposure of the ethmoid and frontal sinuses, in the postero-anterior projection. The glabella is centered on this 6×10 inch area of film, the head resting on the forehead and nose. The cone is centered on the glabella with an average angle of 25 degrees toward the feet, and the cone brought firmly against the head over a small folded towel. On the lower half of the first film is made an exposure of the maxillary sinuses in the postero-anterior projection, with an average angle of 15 degrees toward the feet. The head rests on a small gauze roll beneath the glabella, and the chin. The gauze roll varies in thickness, being of such size that there is no distortion of the nose by pressure on the cassette.

On the upper half of the second film is made an exposure of the sinuses in the postero-anterior oblique projection, the central ray directed through the head at an average angle of 10 degrees toward the head of the patient, centering on the glabella. The head, resting on the forehead and nose (as in the first exposure on film No. 1), is held by a towel across its back, the cone being brought to within one inch of the surface. On the lower half of the second film are made two exposures, both in the lateral projection, at a distance of 32 inches. One view is centered on the sphenoid sinuses, the other on the ethmoid cells and including a lateral view of the frontals and maxillary sinuses. If the size of the mouth permits, a sixth view may be taken upon a mouth film, held in a special cassette of aluminum. This view is made through the top of the head, with the patient supine and the head resting

on a firm pillow. This view, on the mouth film, gives additional information concerning the sphenoid sinuses and some information concerning the ethmoids of the posterior group. Throughout this technic the only special piece of apparatus is the small mouth cassette. A small-aperture cone should be included in all standard apparatus. Children are especially apprehensive of any apparatus which clamps on the head for immobilization. Stereoscopy is not routinely or frequently employed.

The frequency of infections of the nasal accessory sinuses in adults is admitted by all rhinologists and roentgenologists: we have not accorded the same consideration to children. All children with chronic coughs should have an x-ray examination of the nasal accessory sinuses. Before tonsillectomy is resorted to, sinus examinations should be frequently made. In the presence of an otitis media and mastoiditis, it is often advisable to make a sinus x-ray examination, as the sinuses will not infrequently be found affected as well. The syndrome of broncho-sinusitis, recently reviewed by Wasson, is well known to you. Chronic sinus infections may be followed by chronic bronchitis and bronchiectasis. Parents seldom suspect the sinuses in the coughs of children, and all too frequently the child is given a course of tonics and cough mixtures without avail, when the cause of the cough lies in a sinus infection. Many of these patients are afebrile, and clinically appear in quite good health, aside from the distressing cough. Swimming, and especially diving, appear to lead quite frequently to sinus infections.

The common finding in sinusitis of infants and young children is a clouding of the ethmoid cells, and of one, or both, maxillary sinuses. It is probable that the ethmoid infection is primary. Thickening of the trabecular walls is noted in the chronic ethmoid infections. After clearing of the pus from the sinuses, one may note, particu-

larly in the maxillary and sphenoid sinuses, thickening due to hyperplastic changes in the lining membrane. Osteomas may be noted in quite early childhood. Polyps are shown in the maxillary sinuses as circumscribed densities, uniform in shadow density, projecting into the antral cavity. Large polyps in the ethmoid cells may cause a broadening of the ethmoid cell area, and a thinning of the trabeculae. Clearing of a sinus infection may be shown just as definitely by roentgenographic as by clinical examination. I do not believe that the use of opaque oils in sinus examination is either necessary, or advisable, in children. The rapid improvement noted in many of these children, under conservative treatment of the sinus infection, makes it highly advisable that we recognize early sinus infections in children, before the secondary chest pathology has become established. Early recognition and promptly instituted conservative treatment offer our best method of combating these chronic sinus and chest conditions.

CASE REPORTS

D. F., male, age 6 years, came with a complaint of difficulty in breathing through the nose. The right ear drum had been incised, and some tissue had been removed from the right side of the nose. Tonsillectomy and adenoidectomy had been performed two years before the present examination.

X-ray examination of sinuses, Jan. 10, 1930, showed: very small frontal sinuses; cloudy anterior ethmoid cells on both sides; clear posterior ethmoid cells; a very small sphenoid cell on each side anteriorly; a cloudy left maxillary sinus with granulations or polyp formation and a diminished antral space; thickened membrane (hyperplasia) of the right maxillary sinus.

R. S., female, age 7 years, complained of an obstructed nose which had been producing a discharge for the preceding three months. There was difficult breathing at

night, and, although there was no cough, the child cleared her throat frequently. There was an occasional rise of temperature and the patient was quite irritable. Tonsillectomy had been performed four years previous to the present examination. Clinically there was evidence of infection of the anterior sinuses.

X-ray examination of sinuses, Feb. 1, 1930, showed: small, shallow frontal on the right, with increased density; no demonstrable frontal on the left; bilateral cloudy anterior ethmoid cells; cloudy posterior ethmoid cells; small sphenoids in the anterior portion, of indeterminate density; cloudy maxillary sinuses with evidence of polyp formation.

M. B. W., Jr., age 7 years, was brought with the complaint that the left ear had begun to hurt two hours earlier. There was a slight sore throat. The child had had pain in the same ear two and one-half years previously, and the drum was incised at that time. Tonsils and adenoids had been removed twice.

X-ray examination, July 23, 1930, showed: small frontal sinuses, just beginning to extend into the anterior frontal plate; chronic thickening in both anterior and posterior ethmoid groups, with increased density; small sized sphenoids in the anterior portion; increased density of both maxillary sinuses, the right being more dense than the left, with thickened membranes bilaterally.

S. W., male, age 8 years. There was a complaint of frequent colds and enlarged tonsils. Vision was diminished 20/200 in each eye. There was a discharge from the left nostril and increased density of the left antrum on transillumination.

X-ray examination of sinuses, Nov. 22, 1930, showed: small, shallow left frontal; no right frontal development; left frontal cloudy; increased density of both anterior and posterior ethmoid groups; large sphenoid sinuses for a child of this age.

with normal density of the sphenoids. The maxillary sinuses showed markedly increased density, being totally and equally cloudy on the two sides.

W. C., male, age 5 years. The complaint was of a discharge from both ears following an attack of pneumonia. Both ear drums had been incised and were draining. There was a discharge from the nose and clinical evidence of sinusitis.

X-ray examination of sinuses, Jan. 6, 1931, showed: very small frontal sinuses, not extended into the vertical plate of the frontal bone; hazy right anterior ethmoid cells, and totally cloudy left anterior ethmoid cells; cloudy posterior ethmoid cells; very small sphenoid sinuses, lying anteriorly; marked hyperplastic changes in the right maxillary sinus, chronic; total cloudiness of the left maxillary sinus. The chest, the same date, showed chronic mediastinal and tracheobronchial lymphadenitis.

T. D., male, age 6 years, came with a complaint of acute otitis media.

X-ray examination, March 13, 1931, showed: no demonstrable frontal sinus development; small size sphenoids; increased density in both anterior and posterior ethmoid groups and in both maxillary sinuses. The appearance suggested a sinus infection of long standing.

J. M., male, age 5 years, was brought with a history of having been sick with frequent head colds for three months preceding the present examination. Nasal discharge had been profuse, and there had been difficulty in breathing through the nose. There was no earache. The tonsils were chronically infected.

X-ray examination of the sinuses, Apr. 7, 1931, showed: cloudiness throughout all of the nasal accessory sinuses; frontal sinuses small, with the right larger than the left; small sphenoid sinuses; generalized sinus infection.

G. H., female, age 8 years. The child did not talk plainly. She had been recently ex-

amed at school and was told that the right ear was slightly deaf. There was a productive cough, and a discharge from the nose, with much yellowish discharge from the right nostril. There was clinical evidence of a probable maxillary sinusitis.

X-ray examination of the sinuses, Oct. 24, 1930, showed: no development of the frontal sinuses; cloudiness of the anterior ethmoid cells on both sides; total cloudiness of the left antrum; increased peripheral density of the right antrum, with a small central cavity, and evidence of granulations or polyp formation.

H. H., male, age 7 years, 6 months. There had been intermittent cough for the preceding three years. The child had had treatment for sinus infection at various times during this period.

Examination of the sinuses, May 3, 1930, showed: normal frontal sinus development for a child of this age; cloudiness of the right anterior ethmoid cells; total cloudiness of the right maxillary sinus; increased peripheral density, with hyperplasia of the membrane, left maxillary sinus.

Examination on Jan. 27, 1931, showed: both frontal sinuses to be well developed, but both showing increased density; increased density of both anterior and posterior ethmoid groups, with trabecular thickening; sphenoid sinuses of small size, but with increased relative density; increased density of both maxillary sinuses, with demonstrable hyperplasia of the membrane in both.

M. C., female, age 17 years. Examination elicited heart murmur, chronically infected tonsils, and albumin in the urine.

X-ray examination of the sinuses, Jan. 3, 1931, showed: normal sinus development throughout; normal trabecular definition; normal density.

A. P., female, age 16 years. There was clinical evidence of an acute sinus infection.

X-ray examination, March 8, 1931, showed: absence of frontal sinuses; large supra-orbital cell on the left side, ethmoidal; clear right anterior ethmoid cells; left anterior ethmoid cells slightly increased in density, with thickening of the trabeculae; posterior ethmoid cells normally clear; sphenoids small, normal in density. The maxillary sinuses presented hyperplasia of the lining membrane, with a slight increase in general antral density, the left antrum being slightly greater in density than the right.

SUMMARY AND CONCLUSIONS

While it is true that there are technical difficulties to be overcome in roentgenography of the nasal sinuses in infants and young children, patience and attention to detail are rewarded here, as elsewhere, in proportion to the care exercised. Satisfactory diagnostic roentgenograms are obtained in most instances, and quite accurate analyses of sinus pathology are possible. The roentgenologic study of the nasal accessory sinuses offers a valuable aid to the clinician in his appreciation of the location and degree of sinus infection present, and is a guide to treatment.

Examination of the nasal accessory sinuses should be routinely made of all children with chronic cough, chronic tonsillitis, persistent nasal discharge, otitis media, and mastoiditis. Early recognition of sinus pathology in children, with promptly instituted conservative methods of clinical treatment, offers our best means of preventing the distressing cough, chronic bronchitis, and bronchiectasis which may follow. It is the duty of the roentgenologist to acquaint the medical profession more generally with the frequency of sinus infections in children, and to emphasize the value of roentgenologic examination in the recognition of them.

night, and, although there was no cough, the child cleared her throat frequently. There was an occasional rise of temperature and the patient was quite irritable. Tonsillectomy had been performed four years previous to the present examination. Clinically there was evidence of infection of the anterior sinuses.

X-ray examination of sinuses, Feb. 1, 1930, showed: small, shallow frontal on the right, with increased density; no demonstrable frontal on the left; bilateral cloudy anterior ethmoid cells; cloudy posterior ethmoid cells; small sphenoids in the anterior portion, of indeterminate density; cloudy maxillary sinuses with evidence of polyp formation.

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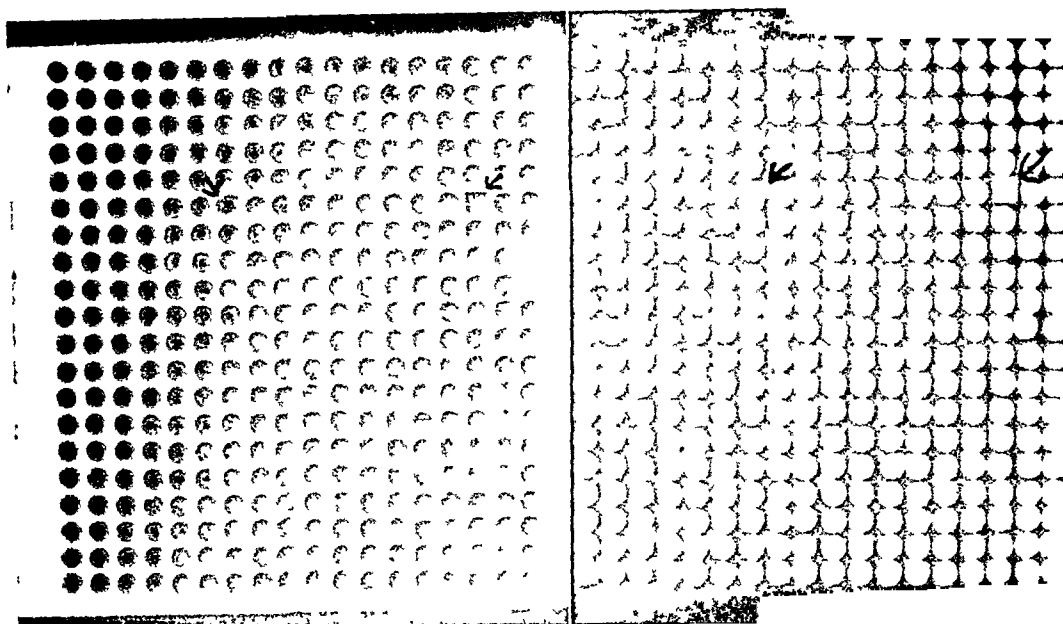


Fig 1 On the left is a photograph of the lead perforator of 0.5 sq cm perforation to each sq cm of lead. Note the two eccentric square perforations, also the wide margin of lead on the left. These are used for replacement of the perforator in the identical position on the skin when the entire dose is not given in one sitting. On the right is a photograph of the reciprocal perforator made by placing the lead cutouts in the perforator, or a paper pattern of the lead perforator. A solution of acetocellulose or collodion or glue is then poured over the pieces of lead, after which washed-off film or paper is placed over it and allowed to dry for a few days. When thoroughly dried, the lead cutouts are gently pushed out of the perforator, without displacement, in order to insure a perfect reciprocal. The other side is now fastened to another piece of celluloid and is ready for use.

forator, furnishing sufficient nucleus of healthy skin for replacement of the treated area.

After four months' trial with these perforators, the one in Group 4, with circular openings, comprising one-half the total square area, was found most satisfactory for continued study.

We may ask at this point: Must we deliver a total of two, three, or four erythema doses at one sitting, or may we divide the dosage and still give the skin the necessary protection of the perforator?

By the following method division is made possible, if so desired. The perforator (Fig 1) is about 20 cm square, and is fastened to the skin with adhesive. At two eccentric points the holes are of slightly different shape. These variations allow the marking of the skin with mercurochrome or any other dye non-opaque to the x-ray, in order that

the perforator may be replaced over exactly the same area at the next session of the treatment. This enables the delivery of the total dose in more than one sitting. Sometimes a paraffin cast must be made and placed against a movable part, such as the neck or arm, in order to assure the same position of flexion of the parts at subsequent sessions.

The efficacy of this method of radiation was investigated along three different lines: (I) with water and paraffin phantoms, to determine experimentally just what percentage of the delivered radiation a body placed at different depths does receive through the perforator, (II) the difference in effect of a given dose without the perforator and an equivalent dose with it, tried experimentally on animals, and (III) the clinical application.

Taking up these studies in the order

THE VALUE OF A MULTI-PERFORATED SCREEN IN DEEP X-RAY THERAPY¹

A PRELIMINARY REPORT ON A NEW METHOD OF DELIVERING MULTIPLE ERYTHEMA DOSES WITHOUT PERMANENT INJURY TO THE SKIN

By F. LIBERSON, M.D., Roentgenologist, U. S. Marine Hospitals, STAPLETON, ELLIS ISLAND, and NEW YORK CITY

THE deleterious effect on the skin of delivering large doses of x-rays to an underlying tumor has been frequently the main deterrent to the successful treatment of malignancies. The method at present proposed to circumvent this difficulty is based on the fact, well known to all x-ray therapists, that when small areas of skin are treated, as in epitheliomas or verrucae, large doses of radiation (from four to six erythema doses to an area 1 cm. in diameter) can be given with safety. Apparently the presence of adjoining normal tissue protects the small radiated area from vesiculation and ulceration.

Taking advantage of this observation, the author began a study of the effects of radiating deep structures through numerous small areas simultaneously (say, from 200 to 400 areas per large portal). The radiation is delivered through a multi-perforator, a sheet of lead from 1.5 mm. to 2 mm. in thickness, with uniform perforations regularly spaced and comprising a definite percentage of the total square area. This perforated lead sheet is placed on the skin. The perforations obviously can be of different sizes and shapes, exposing more or less of the skin to direct radiation, and leaving greater or smaller isthmuses of normal skin, protected by lead, to act as centers of healing in case the radiation is of such magnitude as to cause ulceration of the radiated skin.

Some of the designs tried out were as follows:

1. Strips of lead 1 cm. wide and 20 cm.

long, 10 in number, fastened to a 20×20 cm. piece of celluloid, 1 cm. space between the strips of lead. This design was found not to be servicable on account of insufficient protection to the skin.

2. Lead squares, 1×1 cm. each, arranged in a checkerboard fashion, fastened to a piece of celluloid, alternating the lead squares with equal spaces. This method was found to be unserviceable on account of the difficulties of proper construction and insufficiency of protection.

3. A latticework effect in a sheet of lead, obtained by punching out squares, lozenge shapes, or hexagonal perforations, leaving an area of one-half the original area. This method has been found to be unserviceable when (1) the perforations are of 1 sq. cm. area, on account of too narrow, uniform isthmuses of protected skin, resulting in insufficient protection; (2) when perforations are of less than 0.5 sq. cm. area, the angles interfering with delivery of maximum radiation, especially if the perforator has to be bent over the treated area, and forms an angle with a perpendicular to the central ray.

4. Round or oval perforations of varying sizes from 2 to 8 mm. in diameter, the perforated area comprising two-thirds, one-half, or one-fourth of the total area. This type is not difficult of construction and offers the maximum skin protection, especially if the perforations are less than 8 mm in diameter. The reason for the greatest protection is found in the fact that the spaces between the perforations have varying diameters, narrowest in the axis of the cross diameter of the perforator, and largest in the axis of the oblique diameter of the per-

¹Approved for publication by the Surgeon General, U S Public Health Service
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TABLE I. DETERMINATION OF THE QUANTITY OF RADIATION AT DIFFERENT DEPTH OF PHANTOM WITH THE PERFORATOR

Constants: 4 ma.; 70 cm. target-ionometer distance; filter, 1 mm. Al, 2 cm. wood.

125 P.K.V.	Depth in phantom (cm.)	0.25 mm. Cu			0.5 mm. Cu			0.75 mm. Cu			1 mm. Cu		
		I	II	III	I	II	III	I	II	III	I	II	III
				%			%			%			%
	1	4.8	59.3	+1.2	3.1	59.	+1.7	2.1	58.7	+2.3	1.8	59.3	+1.7
	2	4.1	59.	+1.7	3.	59.	+1.7	2.	59.7	+0.6	1.7	58.3	+2.9
	3	3.8	60.3	-0.6	2.7	59.7	+0.6	2.	59.	+1.7	1.6	58.7	+2.3
	4	3.3	59.7	+0.6	2.1	58.7	+2.3	1.8	59.7	+0.6	1.3	59.3	+1.2
	5	2.7	58.7	+2.3	2.	59.3	+1.2	1.5	59.3	+1.2	1.2	59.	+1.7
	6	2.4	59.7	+0.6	1.6	60.	+0.	1.3	59.	+1.7	1.	59.	+1.7
	7	2.3	59.	+1.7	1.5	59.7	+0.6	1.1	59.7	+0.6	0.9	58.3	+2.9
	8	2.1	59.7	+0.6	1.2	59.	+1.7	1.	58.3	+2.9	0.7	59.7	+0.6
	9	2.	59.3	+1.2	1.1	59.7	+0.6	0.8	59.7	+0.6	0.6	59.	+1.7
	10	1.7	58.	+3.5	0.9	59.3	+1.2	0.6	59.3	+1.2	0.5	59.7	+0.6
155 P.K.V.	1	8.6	59.7	+0.6	5.9	59.3	+1.2	4.3	59.	+1.7	3.8	59.6	+0.6
	2	7.2	59.	+1.7	5.5	59.	+1.7	3.9	59.3	+1.2	3.4	60.3	-1.7
	3	7.	59.	+1.7	5.1	59.3	+1.2	3.8	59.3	+1.2	3.3	59.	+1.7
	4	6.5	60.	+0.	4.8	59.3	+1.2	3.4	60.	+0.	3.1	58.6	+2.3
	5	6.2	59.	+1.7	4.4	59.7	+0.6	3.2	59.7	+0.6	3.	59.6	+0.6
	6	5.7	58.7	+2.3	4.1	60.	+0.	3.	59.3	+1.2	2.9	59.	+1.7
	7	5.2	59.3	+1.2	3.6	58.7	+2.3	2.8	59.	+1.7	2.7	59.3	+1.2
	8	4.7	58.7	+2.3	3.4	59.	+1.7	2.6	58.7	+2.3	2.3	59.6	+0.6
	9	4.3	59.3	+1.2	3.3	59.	+1.7	2.3	58.7	+2.3	2.1	59.	+1.7
	10	3.9	58.7	+2.3	3.	59.7	+0.6	2.1	59.3	+1.2	1.8	59.3	+1.2
186 P.K.V.	1	10.4	61.	-1.7	9.	61.	-1.7	7.	60.	+0.	5.2	59.	+1.7
	2	9.8	60.3	-0.6	7.9	59.7	+0.6	6.	60.	+0.	4.4	58.7	+2.3
	3	8.8	59.7	+0.6	7.	58.7	+2.3	5.7	58.	+3.4	4.1	58.	+3.5
	4	8.	59.7	+0.6	5.9	59.	+1.7	4.8	58.	+3.5	3.6	58.3	+2.9
	5	7.3	59.	+1.7	5.	58.7	+2.3	4.	58.	+3.5	3.3	58.	+3.5
	6	6.	58.	+3.5	4.3	58.7	+2.3	3.8	58.3	+2.9	3.1	58.	+3.5
	7	5.7	58.3	+2.9	4.2	59.3	+1.2	3.6	59.	+1.7	3.	58.3	+2.9
	8	5.4	59.	+1.7	4.	59.3	+1.2	3.4	58.3	+2.9	2.6	58.	+3.5
	9	4.7	10.	+0.	3.8	59.	+1.7	3.	58.3	+2.9	2.2	58.	+3.5
	10	4.	59.	+1.7	3.1	59.7	+0.6	2.5	59.7	+0.6	1.9	59.7	+0.6
200 P.K.V.	1	12.3	60.3	-0.6	10.4	60.	+0.	7.8	59.7	+0.6	6.5	60.	+0.
	2	12.	60.7	-1.2	9.	60.	+0.	7.	58.	+3.3	6.	58.3	+2.8
	3	11.1	58.7	+2.2	8.9	59.	+1.7	6.7	59.	+1.7	5.6	58.	+3.3
	4	10.8	58.7	+2.2	8.	59.3	+1.2	5.9	59.3	+1.2	4.5	58.3	+2.8
	5	7.6	59.3	+1.2	6.1	59.	+1.7	5.2	59.	+1.7	4.1	59.	+1.7
	6	7.4	58.7	+2.2	5.8	59.	+1.7	5.1	58.7	+2.2	1.	58.	+3.3
	7	7.2	58.7	+2.2	5.6	58.3	+2.8	4.8	58.	+3.3	3.9	58.7	+2.2
	8	6.9	59.7	+0.6	5.1	58.3	+2.8	4.	58.3	+2.8	3.4	58.3	+2.8
	9	5.9	59.7	+0.6	4.4	59.3	+1.2	3.8	58.	+3.3	3.1	58.3	+2.8
	10	5.7	59.	+1.7	4.	60.	+0.	3.3	59.3	+1.2	2.6	60.	+0.

Each ionometric reading here recorded is the mean of four readings, taken at various hours of the day.

Column I represents the quantity of ionization in 30 seconds at the depth indicated.

Column II represents the time required to get same ionometric reading with the perforator of 0.5 sq. cm. perforation to each sq. cm. of lead interposed.

Column III represents the percentage of radiation above or below 50, transmitted through the perforator, calculated from Column II.

Note that at no single reading is the variation over 3.5 per cent; within range of experimental error.

enumerated, the writer arrived at the following results.

I

The theoretical part of this investigation concerning the actual dosage received at

above 8 cm., more than the theoretical half of the radiation comes through, especially with the higher voltages. This may be attributed to the slight additional radiation coming from the higher voltages, which

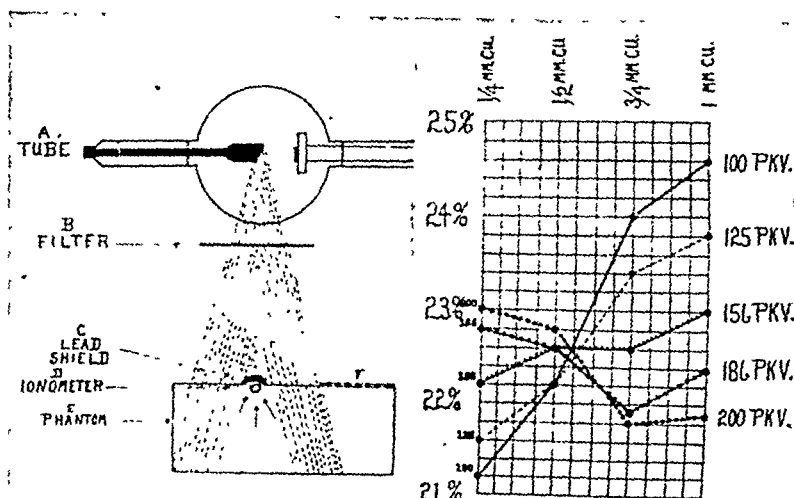


Fig. 2. Determination of back-scattering: On the left is an arrangement of A, tube; B, filter; C, $\frac{1}{4}$ in. lead cover on ionometer to shield it from direct radiation; D, ionometer; E, phantom; F, cross-section of perforator to show how the study of the back-scattering with the shielded ionometer simulates the condition of the skin under the lead isthmuses of the perforator.

The graph on the right indicates the range of back-scattering from 21 to 24.5 per cent. Note that the greatest back-scattering is present in the highest filtration with the lowest voltage here tested.

varying depths of phantom, with and without the perforator, is charted in Table I. A careful study shows that with the perforations comprising one-half of the square area, the radiation received by a body about 5 cm. under the perforator, is almost exactly half the radiation received without the perforator, as is to be expected theoretically. In cases in which the ionization chamber is very close to the perforator, however, the skin often receives less than half the total radiation, because the chamber is so small (the writer used the Wolf chamber) that it often fails to cover a characteristic square area with one-half square area of perforation in it. With the larger (Duane) chamber, this difficulty is entirely obviated. Conversely, as the ionometer depth reaches

penetrates partially through the lead of the perforator, if it is less than 2 millimeters thick.

Of great importance is the consideration that the skin receives not only the radiation delivered directly to it, but also the secondary reflected rays of back-scattering. Table II and Figure 2 show that fully from 21 to 24.5 per cent of the total radiation (depending upon the voltage and filter used) will be scattered back to the skin after it has penetrated to the deeper structures. This means that even in cases in which the skin is protected by the isthmuses of lead from direct radiation, it will receive by back-scattering almost a full erythema dose for every four erythema doses delivered through the perforator. This would tend to

TABLE I. DETERMINATION OF THE QUANTITY OF RADIATION AT DIFFERENT DEPTH OF PHANTOM WITH THE PERFORATOR

Constants: 4 ma.; 70 cm. target-ionometer distance; filter, 1 mm. Al, 2 cm. wood.

125 P.K.V.	Depth in phantom (cm.)	0.25 mm. Cu			0.5 mm. Cu			0.75 mm. Cu			1 mm. Cu		
		I	II	III %	I	II	III %	I	II	III %	I	II	III %
	1	4.8	59.3	+1.2	3.1	59.	+1.7	2.1	58.7	+2.3	1.8	59.3	+1.7
	2	4.1	59.	+1.7	3.	59.	+1.7	2.	59.7	+0.6	1.7	58.3	+2.9
	3	3.8	60.3	-0.6	2.7	59.7	+0.6	2.	59.	+1.7	1.6	58.7	+2.3
	4	3.3	59.7	+0.6	2.1	58.7	+2.3	1.8	59.7	+0.6	1.3	59.3	+1.2
	5	2.7	58.7	+2.3	2.	59.3	+1.2	1.5	59.3	+1.2	1.2	59.	+1.7
	6	2.4	59.7	+0.6	1.6	60.	+0.	1.3	59.	+1.7	1.	59.	+1.7
	7	2.3	59.	+1.7	1.5	59.7	+0.6	1.1	59.7	+0.6	0.9	58.3	+2.9
	8	2.1	59.7	+0.6	1.2	59.	+1.7	1.	58.3	+2.9	0.7	59.7	+0.6
	9	2.	59.3	+1.2	1.1	59.7	+0.6	0.8	59.7	+0.6	0.6	59.	+1.7
	10	1.7	58.	+3.5	0.9	59.3	+1.2	0.6	59.3	+1.2	0.5	59.7	+0.6
155 P.K.V.	1	8.6	59.7	+0.6	5.9	59.3	+1.2	4.3	59.	+1.7	3.8	59.6	+0.6
	2	7.2	59.	+1.7	5.5	59.	+1.7	3.9	59.3	+1.2	3.4	60.3	-1.7
	3	7.	59.	+1.7	5.1	59.3	+1.2	3.8	59.3	+1.2	3.3	59.	+1.7
	4	6.5	60.	+0.	4.8	59.3	+1.2	3.4	60.	+0.	3.1	58.6	+2.3
	5	6.2	59.	+1.7	4.4	59.7	+0.6	3.2	59.7	+0.6	3.	59.6	+0.6
	6	5.7	58.7	+2.3	4.1	60.	+0.	3.	59.3	+1.2	2.9	59.	+1.7
	7	5.2	59.3	+1.2	3.6	59.7	+2.3	2.8	59.	+1.7	2.7	59.3	+1.2
	8	4.7	58.7	+2.3	3.4	59.	+1.7	2.6	58.7	+2.3	2.3	59.6	+0.6
	9	4.3	59.3	+1.2	3.3	59.	+1.7	2.3	58.7	+2.3	2.1	59.	+1.7
	10	3.9	58.7	+2.3	3.	59.7	+0.6	2.1	59.3	+1.2	1.8	59.3	+1.2
186 P.K.V.	1	10.4	61.	-1.7	9.	61.	-1.7	7.	60.	+0.	5.2	59.	+1.7
	2	9.8	60.3	-0.6	7.9	59.7	+0.6	6.	60.	+0.	4.4	58.7	+2.3
	3	8.8	59.7	+0.6	7.	58.7	+2.3	5.7	58.	+3.4	4.1	58.	+3.5
	4	8.	59.7	+0.6	5.9	59.	+1.7	4.8	58.	+3.5	3.6	58.3	+2.9
	5	7.3	59.	+1.7	5.	58.7	+2.3	4.	58.	+3.5	3.3	58.	+3.5
	6	6.	58.	+3.5	4.3	58.7	+2.3	3.8	58.3	+2.9	3.1	58.	+3.5
	7	5.7	58.3	+2.9	4.2	59.3	+1.2	3.6	59.	+1.7	3.	58.3	+2.9
	8	5.4	59.	+1.7	4.	59.3	+1.2	3.4	58.3	+2.9	2.6	58.	+3.5
	9	4.7	10.	+0.	3.8	59.	+1.7	3.	58.3	+2.9	2.2	58.	+3.5
	10	4.	59.	+1.7	3.1	59.7	+0.6	2.5	59.7	+0.6	1.9	59.7	+0.6
200 P.K.V.	1	12.3	60.3	-0.6	10.4	60.	+0.	7.8	59.7	+0.6	6.5	60.	+0.
	2	12.	60.7	-1.2	9.	60.	+0.	7.	58.	+3.3	6.	58.3	+2.8
	3	11.1	58.7	+2.2	8.9	59.	+1.7	6.7	59.	+1.7	5.6	58.	+3.3
	4	10.8	58.7	+2.2	8.	59.3	+1.2	5.9	59.3	+1.2	4.5	58.3	+2.8
	5	7.6	59.3	+1.2	6.1	59.	+1.7	5.2	59.	+1.7	4.1	59.	+1.7
	6	7.4	58.7	+2.2	5.8	59.	+1.7	5.1	58.7	+2.2	4.	58.	+3.3
	7	7.2	58.7	+2.2	5.6	58.3	+2.8	4.8	58.	+3.3	3.9	58.7	+2.2
	8	6.9	59.7	+0.6	5.1	58.3	+2.8	4.	58.3	+2.8	3.4	58.3	+2.8
	9	5.9	59.7	+0.6	4.4	59.3	+1.2	3.8	58.	+3.3	3.1	58.3	+2.8
	10	5.7	59.	+1.7	4.	60.	+0.	3.3	59.3	+1.2	2.6	60.	+0.

Each ionometric reading here recorded is the mean of four readings, taken at various hours of the day.

Column I represents the quantity of ionization in 30 seconds at the depth indicated.

Column II represents the time required to get same ionometric reading with the perforator of 0.5 sq. cm. perforation to each sq. cm. of lead interposed.

Column III represents the percentage of radiation above or below 50, transmitted through the perforator, calculated from Column II.

Note that at no single reading is the variation over 3.5 per cent; within range of experimental error.

set the safe limit of radiation through the perforator at four erythema doses.

An equally important consideration is the homogeneity of the radiation. Since the radiation delivered comes in streamers

tube after half the radiation has been delivered. Thus, with a skin-target distance of 60 cm., perforations 1 cm. apart, *i.e.*, 0.5 cm. from center to periphery, and the lesion 10 cm. from the surface, an almost homo-

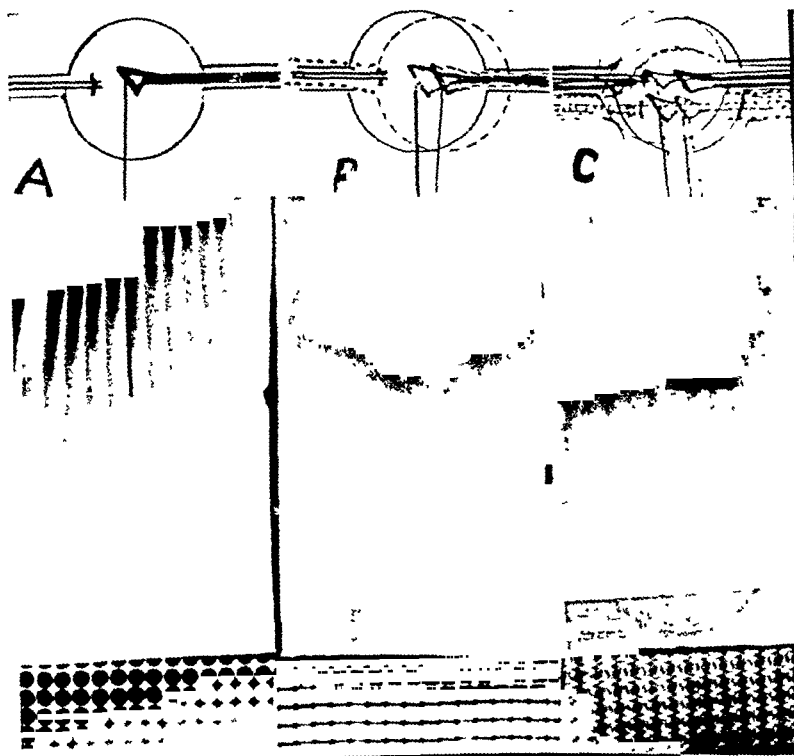


Fig. 3. Shows how the shifting of the position of the tube converts the streamer radiation as seen in *A* to almost homogeneous radiation in one plane, as seen in *B*, and to almost homogeneous radiation in all planes (at predetermined depth), as seen in *C*. The upper part of the figure shows the positions of the tube for the exposures recorded on the films below. The middle portions represent the appearance of the streamers in the vertical plane. The bottom of this figure shows the appearance of the corresponding streamers in the horizontal plane at 10 cm. from the surface of the phantom under the perforator. In *A*, the entire radiation was delivered with the tube in one position. In *B*, half of the radiation was delivered with the tube in one position, the other half after shifting the tube 3 cm. in one direction. In *C*, one-quarter of the radiation was delivered from each of the four positions of the tube.

through the holes in the perforator, it is evidently not homogeneous, except at great depths. This lack of homogeneity may even be a desirable feature, and it is to be investigated further from just that point of view. However, if homogeneity is desired, it may be obtained by changing the position of the

geneous radiation in one plane is obtained if the tube is moved 3 cm. and half the dose is delivered from each of the two positions (Fig. 3). For greater homogeneity yet, one-fourth of the dose may be delivered from each of four positions, 3 cm. apart, as indicated in Figure 3. If the lesion happens

TABLE II. DETERMINATION OF BACK-SCATTERING IN PERCENTAGE OF TOTAL RADIATION

Kilovolts	Filters :	0.25 mm. Cu			0.5 mm. Cu			0.75 mm. Cu			1 mm. Cu		
		I		II	I		II	I		II	I		II
		30 sec.	Minutes	Seconds	30 sec.	Minutes	Seconds	30 sec.	Minutes	Seconds	30 sec.	Minutes	Seconds
100 K.V.		3.6	2	22	1.9	2	15	1.1	2	5	0.8	2	3
		3.5	2	20	1.9	2	15	1.1	2	5	0.8	2	3
		3.5	2	20	1.9	2	15	1.1	2	5	0.8	2	2
		3.5	2	21	1.9	2	15	1.1	2	5	0.8	2	2
Percentage of radiation		21.2%			22.2%			24%			24.5%		
125 K.V.		6.2	2	20	3.8	2	15	2.5	2	7	1.9	2	6
		6.2	2	17	3.8	2	15	2.4	2	8	1.9	2	7
		6.1	2	17	3.8	2	15	2.4	2	8	1.9	2	7
		6.1	2	17	3.8	2	15	2.5	2	7	1.9	2	6
Percentage of radiation		21.8%			22.2%			23.5%			23.8%		
156 K.V.		9.9	2	15	6.7	2	12	5.2	2	13	4.3	2	10
		10.	2	15	6.7	2	12	5.3	2	12	4.3	2	10
		9.9	2	15	6.8	2	12	5.3	2	12	4.3	2	10
		10.	2	15	6.7	2	12	5.2	2	12	4.3	2	10
Percentage of radiation		22.2%			22.6%			22.6%			23%		
186 K.V.		14.1	2	12	10.4	2	12	8.	2	17	6.2	2	12
		14.	2	11	10.3	2	12	8.1	2	16	6.2	2	14
		14.	2	11	10.4	2	10	8.	2	17	6.2	2	14
		14.1	2	12	10.3	2	14	8.	2	18	6.2	2	14
Percentage of radiation		22.8%			22.6%			21.9%			22.4%		
200 K.V.		16.4	2	10	11.7	2	10	8.7	2	15	7.5	2	16
		16.2	2	10	11.8	2	12	8.8	2	17	7.5	2	16
		16.6	2	10	11.7	2	12	8.8	2	17	7.5	2	16
		16.4	2	10	11.8	2	10	8.7	2	17	7.5	2	15
Percentage of radiation		23%			22.8%			21.8%			22.1%		

Constant throughout the experiment: Target-ionometer distance, 60 cm.; 4 ma.; filter, 1 mm. Al, 2 cm. wood. Variants: Voltage and Cu filter. Phantom: paraffin (30 cm. block); also basin of water (20 cm. deep). Arrangement of experiment: See Figure 2.

Column I represents the ionometric reading in 30 seconds from the radiation and filter above indicated. Column II, the time in minutes and seconds to get the same ionometric reading with the ionometer shielded by lead from all direct radiation. The column marked "Percentage of radiation" shows the total percentage of back-scattering. The findings are graphed in Figure 2.

to be less than 10 cm. from the skin surface, the tube is moved more than 3 cm., as simple arithmetic proportion indicates.

II

The biological effect of radiation through the perforator was tried on ova, on white mice and on rabbits. In the ova, the findings were not critical. In the case of mice, the animals were treated *in toto*, being considered as tumor implants. The mice were placed at depths of 5, 7, and 10 cm. from the surface of a phantom of paraffin (Table III). The results show that whereas

three erythema doses delivered without the perforator killed the majority in from 8 to 20 days, the equivalent ionometric radiation through the perforator killed the majority of those mice in less than 8 days. The perforator radiation apparently has effective "destruction potency."

In the treatment of the rabbits, localized areas of skin were exposed to radiation rather than the whole animal, approximating more closely the clinical use of the method. The theoretical part of the investigation had established the fact that the half square area perforator delivered half

TABLE III

Number of animals	3	3	3	6	6	6	4	4	4	4	4	4
P.K.V.	125			186			186			186		
Ma.	4			4			4			4		
Distance from target to mouse	30 cm.			40 cm.			60 cm.			60 cm.		
Distance from target to phantom							50	50	50	50	50	50
Filters in mm. aluminum	0			1	1	1	1	1	1	1	1	1
Filters in mm. copper	0			0			1/4	1/4	1/4	1/4	1/4	1/4
Time in sec., min., or hours	5m.	10m.	20m.	15m.	30m.	30m.	2 hr.	2.5 hr.	3 hr.	4 hr.	5 hr.	6 hr.
Ionization in r units at position of animal	3.6 r per sec.			58 r per min.			16 r per min.			16 r per min.		
Total r units delivered to animal	1080	2160	2160	870	1740	870	1920	2400	2880	1920	2400	280
Phantom thickness above	0	0	0	0	0	0	7cm.	7cm.	7cm.	7cm.	7cm.	7cm.
Phantom thickness under	0	0	0	0	0	0	20cm.	20cm.	20cm.	20cm.	20cm.	20cm.
Exodus within 1 hour			2									
Exodus within 24 hours		2	1		2				1			
Exodus within 8 days						1		1	2	1	4	4
Exodus within 20 days	2	1		2	4	1	1	3	1	3		
No exodus in 1 month	1			4		4	3					

Table III. The numbers in italics represent animals treated with the perforator. Note that in the last three columns on the right, most of the animals died before the eighth day. In the next three columns although the equivalent radiation has been given without the perforator, the majority of the animals treated died after eight days.

the total radiation to the underlying tissues. If the limit of safe radiation without the perforator is now determined, and we can give with safety more than twice that dose with the perforator, its usefulness is clearly demonstrated. This is exactly what occurred with the rabbits. The dose necessary to cause epilation within 15 days on one side of the buttocks and back of four rabbits was determined. Three times this

dose delivered to the other side of the back and buttocks through the perforator caused only slight epilation after 21 days. In four other rabbits the lower back and buttocks were epilated by chemicals, and the minimum dose that causes slight ulceration and crusting of the skin was determined. Three times this dose delivered to the other side through the perforator caused no ulceration in any of the animals, and only faint crusting in one (Fig. 4).



Fig. 4. On the right side a dose sufficient to cause crusting was given. On the left, three times this dose was delivered through the perforator with even less permanent damage to the skin.

III

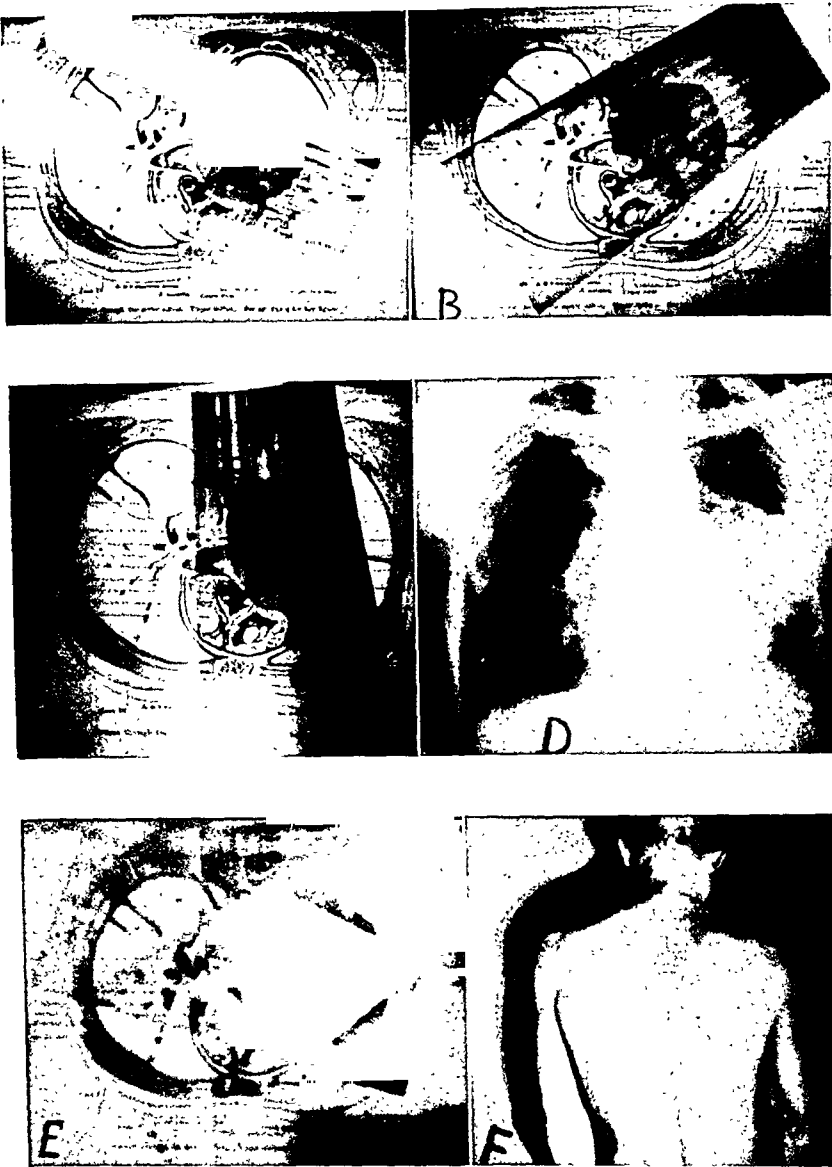
The clinical investigation of this method has been quite limited, of course, to date. In normal volunteers, an erythema dose was delivered to the shaved thigh, and three erythema doses were given through the perforator to a corresponding area. There was no vesiculation or ulceration in either area. A few resistant skin lesions were treated with the 0.25 sq. cm. perforator, giving three erythema doses with no vesiculation. However, the marks of the perforations lasted 8 months.

In working out the technic of the application of this method in the actual treatment

of tumors, due cognizance was taken of the site of exit of the rays as well as the site of entry on the skin. When looking for all possible skin fields of entrance for the rays,

the site of exit of previous radiation must be assiduously avoided. The exact technic, as developed to the present, is as follows:

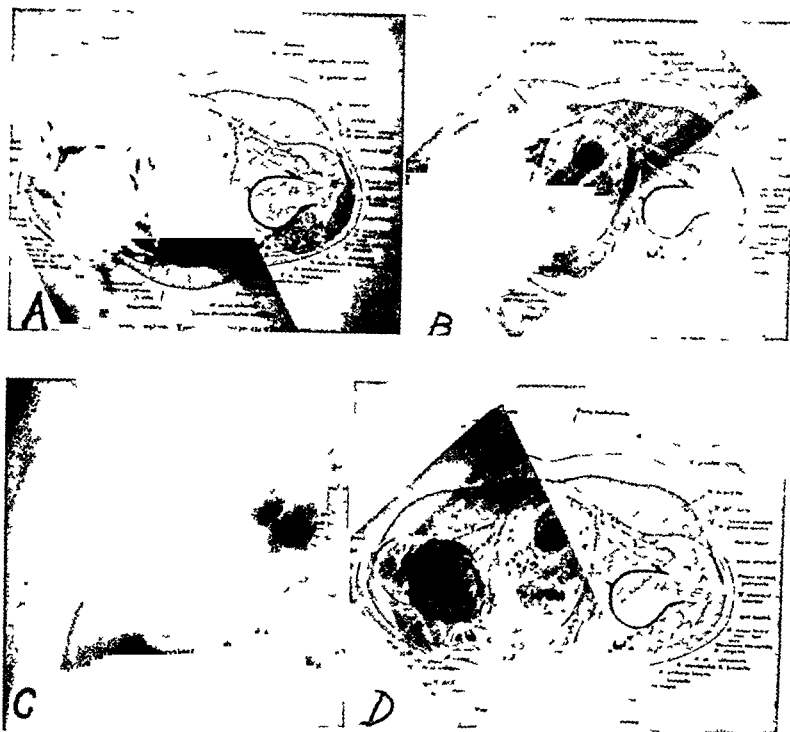
The lesion, in its exact size, shape, and



Figs. 5-A to 5-F. These show the arrangements of the portals of treatment in a case of neoplasm of the left side of the chest *D*, with metastasis in the cervical spine. The tumor is plotted on a topographical cross-section of the chest. *A* shows the plotting of one of the suitable streamers of size sufficient to cover the tumor by a small margin, the streamer directed from the left axilla anterior to the right axilla posterior. *B*, directing the streamer from the left axilla posterior to the right axilla anterior. *C*, from the left back to the left front. Note that in *E* all streamers cross in the region of the tumor, but neither the entrance nor the exit rays cross at any skin surface. *F* shows the appearance of the skin two weeks after treatment with three erythema doses through the perforator.

situation, is charted on one of the topographical cross-section films of the body at that segmental level, and the distance from the various skin surfaces is marked. The

Sometimes one portal is directed upward toward the head, and the portal from the opposite surface of the body is directed toward the feet, in order to avoid crossing of



Figs 6-A to 6-D Show the plan of radiation applied to an osteogenic sarcoma of the femur (C) in a man of 42, with metastasis to the lungs. In A the tumor is plotted on a topographical cross-section through the head of the femur, with suitable streamer directed from the gluteal region to the pubes, from the anterior external to the posterior central. The streamers cross in the tumor area as seen in D. In both their entry and exit the streamers avoid each other and are, therefore, satisfactory. However, no room has been left for a third streamer without its crossing in the skin. In such a case the radiologist should plan the maximum radiation through two portals only.

fields of entry and the radiation angles are mapped out with the aid of a model "streamer" that represents the general direction and spread of the characteristic radiation, after it has passed through the perforator. Care is taken that the streamer lines do not meet on the entrance and exit of the rays at the skin surfaces, but meet only in the region of the tumor. The dosages at the depth of the tumor are computed from the dosage charts; then the necessary quantity of radiation is delivered through these portals as outlined by the entrance and exit streamers (Fig 5).

the entrance and exit rays of the opposite surfaces of the body treated. Sometimes the radiation is directed obliquely from one surface to the right side and from the other surface to the left, and sometimes an entire portal may be avoided to diminish the effect from the exit of the rays (Fig 6).

It might be mentioned, finally, that after all suitable areas of skin have been radiated through the perforators, one may still attempt to re-deliver (after a 4-week interval of treatment to the same area) several erythema doses through the isthmuses of normal skin formerly left protected, by us-

ing a reciprocally patterned perforator this second time (Fig. 1). The attempt to do this has been entirely successful and encouraging. The advantage of this form of treatment lies in the fact that while the skin over a portal is recuperating from the radiation, the tumor mass is meanwhile given radiation through a second and a third portal, and by the end of four weeks, the first portal is again ready for a treatment through the formerly protected area.

In the treatment, then, of clinical material, we have to bear in mind the following:

The field of exit of rays must not fall over the field of entrance from the opposite side.

The size of the area treated should be as small as possible, and although amply covering the entire tumor, should do so by a narrow margin only.

At least four weeks should pass after the use of the primary perforator before the reciprocal perforator is used.

At the present moment the practical application of this method is awaiting more extensive investigation as to (1) the limit of

width of the perforator isthmuses; (2) the optimum size and the shape of the perforations; (3) the maximum number of perforated areas with optimum skin protection in skins of various individuals.

SUMMARY

Radiation through a lead sheet, with circular perforations, comprising half the total square area, delivers half the total dose to the underlying tissues. Similarly, if the perforated area comprises two-thirds of the square area, it delivers two-thirds of the total applied radiation. Since the remote effect upon the skin of both rabbits and man is the same when three or four times as much radiation is delivered through the perforator as without it, the underlying tissue actually receives one and a half to two times as much radiation with the perforator as without it.

Because of the increased dosage obtainable without permanent injury to the skin, the author proposes this method for the treatment of selected cases of malignancy.

THE EFFECT OF X-RAYS ON BACTERIA IN MEDIA OF HIGH SPECIFIC GRAVITY

PRELIMINARY REPORT¹

By WAYNE A. JOHNSTON, M.D., DUBUQUE, IOWA

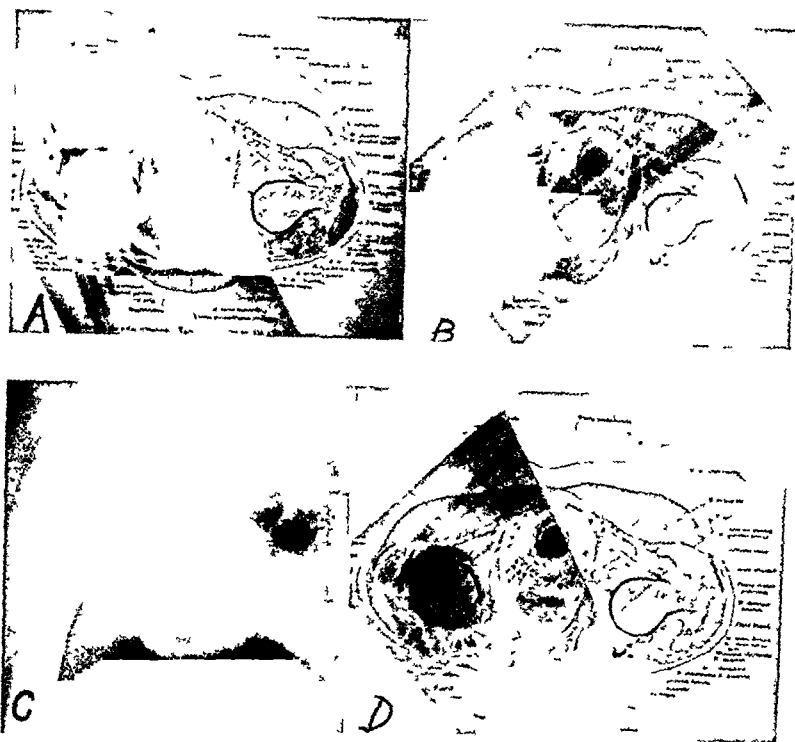
THE older radiologists undoubtedly have noted improvement in some cases following the injection of Beck's paste into a sinus for radiographic purposes, this being especially true in the years between 1908 and 1915 (1, 2). Less improvement has been noted since the latter date. Coinciding with this transition in the results and, therefore, the use of Beck's paste, there was also a transition going on in our x-ray technic and equipment. With the old gas

tube, plates, and no screens, we had to be on constant guard against burning a patient in our effort to secure satisfactory roentgenograms. In other words, at the same time we were making roentgenograms we were actually treating the patient. With the development of the hot cathode tube, films with double emulsion, and intensifying screens, the length of our exposure was very markedly reduced. It is my contention that it was because of this shortened time of exposure that less satisfactory therapeutic results were obtained with Beck's paste. To

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

situation, is charted on one of the topographical cross-section films of the body at that segmental level, and the distance from the various skin surfaces is marked. The

Sometimes one portal is directed upward toward the head, and the portal from the opposite surface of the body is directed toward the feet, in order to avoid crossing of



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It might be mentioned, finally, that after all suitable areas of skin have been radiated through the perforators, one may still attempt to re-deliver (after a 4-week interval of treatment to the same area) several erythema doses through the isthmuses of normal skin formerly left protected, by us-

the paste similarly mixed with bacteria and untreated, showed no inhibition, even after several hours' contact.

controlling factor, I repeated the same experiment with lipiodol, in which iodine is the dominant factor. I found that bacteria



Fig 1 (third plate) Beck's paste 5-A, 5-B, 5-C, Same staphylococci as shown in previous plates, mixed with Beck's paste and treated with x-rays for ten minutes 6-A, 6-B, 6-C, Same mixture, treated for thirty minutes Same x-ray factors

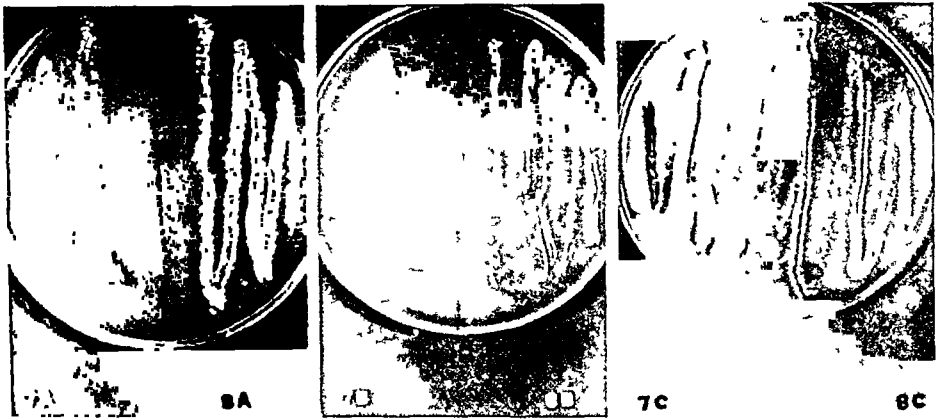


Fig 1 (fourth plate) Beck's paste 7-A, 7-B, 7-C, Same mixture as shown in previous plate, treated for sixty minutes 8-A, 8-B, 8-C, Same mixture as shown in previous plate, untreated for sixty minutes—control Same x-ray factors

My only means of explaining this result is that the presence of a heavy metal, bismuth, in the paste produced sufficient secondary x-rays to intensify the action of the rays, causing a deleterious action on the bacteria. Perhaps the explanation lies in the fact that these secondary rays, being much softer, have a more effective action against the bacteria. There is considerable work being done now on the effect of the extreme soft ray on bacteria.

In order to substantiate my conclusion that the presence of a heavy metal was the

are very little, if any, affected by standing in lipiodol, but that, when the staphylococci-lipiodol mixture was exposed to x-rays, the degree of inhibition seemed to progress at almost the same rate as was found in Beck's paste.

A similar experiment was performed with bacteria suspended in a solution of barium sulphate, but no inhibition was found. This experiment was performed only once: I expect to repeat it later. The atomic weight of barium is 137.37 as compared to bismuth, 208, and iodine, 126.92. Either

verify this opinion I undertook the work which follows.

Pure and fresh cultures of *Staphylococ-*

of 5 minutes, it was found that there was some inhibition of bacterial growth in the paste, which increased with the various time

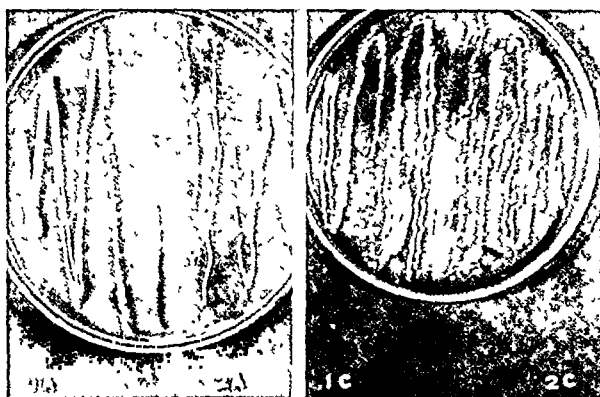


Fig. 1 (first plate) Beck's paste. 1-A, 1-C, Staphylococci suspended in normal salt solution 2-A, 2-C, Staphylococci suspended in normal salt solution after exposure to x-rays for one hour X-ray factors: 110 K.V., 5 ma, 0 filter, 10-in. distance.

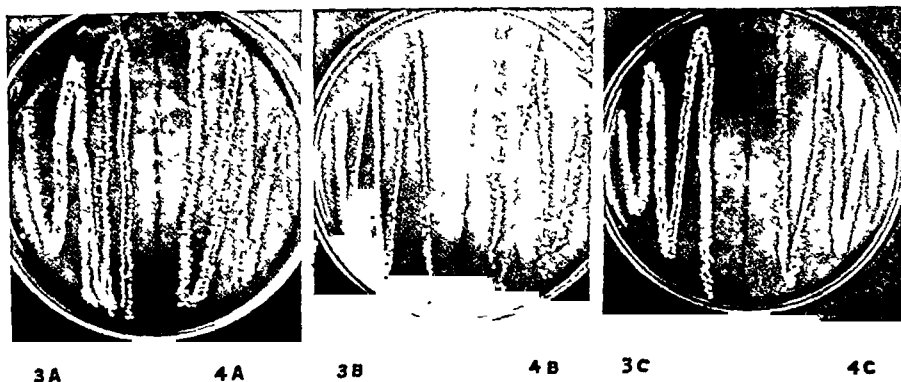


Fig. 1 (second plate) Beck's paste 3-A, 3-B, 3-C, Staphylococci mixed with Beck's paste—control 4-A, 4-B, 4-C, Staphylococci mixed with Beck's paste and treated with x-rays for five minutes. Same x-ray factors

cus aurcus, obtained from boils, were grown on agar. A platinum loop of these bacteria was mixed with 1 oz. Beck's paste. A similar loop of the same bacteria was mixed with 1 oz. physiologic salt solution, and the two mixtures were simultaneously exposed to x-rays, the factors being 110 K.V., 5 ma., 0 filter, and 10 in. focal distance. Single loops of the suspension and of the paste were transferred to agar plates at intervals of 5, 10, 30, and 60 minutes. At the end

intervals, up to 60 minutes, when there was very marked inhibition. There was no inhibition in the growth of bacteria transferred from the suspension even after 60 minutes of exposure. This finding is in agreement with a very excellent résumé of the literature by Klövekorn (3). The exposure was repeated nine times, each time with a fresh culture of *Staphylococcus* from a different source. The same result was always obtained. Control cultures, taken from

tors of exposure were used as in the paraffin experiment. This procedure was followed six times and in each experiment there was some inhibition of growth after

The greatest inhibition is at or near the surface, and the least at the bottom, after one hour of exposure. This would be expected, due to the absorption of the x-rays.

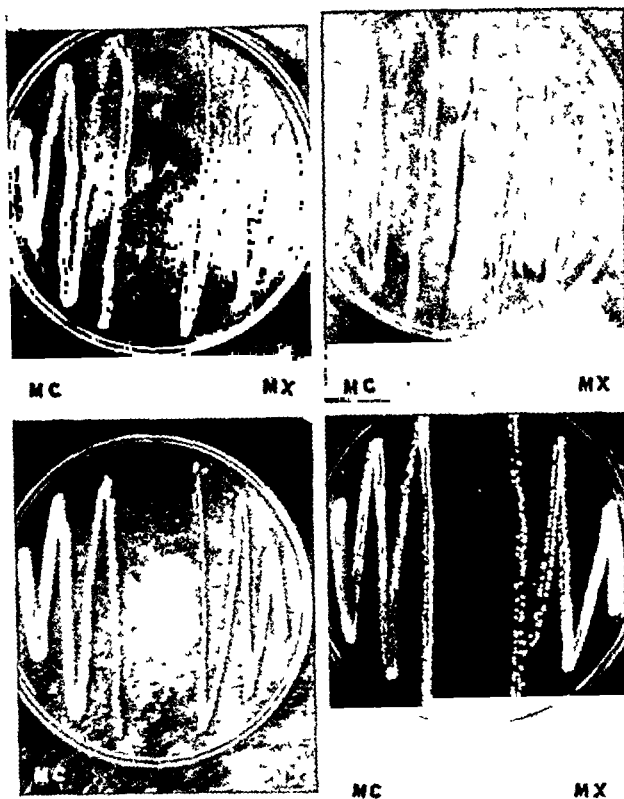


Fig. 2 (third plate) Meat MC, Staphylococci suspended in normal salt solution after standing for one hour in a paraffin-coated gelatin capsule—control. The suspension was thoroughly mixed just before the culture was made. MX, Same suspension, in small paraffin-coated gelatin capsule buried 1 cm. in piece of lean meat 6×6×6 in., and treated for one hour with x-rays. The suspension was again thoroughly mixed just before the culture was made. X-ray factors 135 KV, 5 ma, 0 filter, 10-in. distance.

one hour of treatment. I cannot explain the difference in my finding between paraffin and meat, unless there are sufficient atoms of high atomic weight in the protein molecule to produce more secondary radiation than the paraffin does, and so inhibit the bacterial growth.

Using Beck's paste and the factors 110 K.V., 5 ma., 0 filter, and 10 in. focal distance, it was also found that, by making subcultures at different levels from the surface down, inhibition decreased accordingly

There was no difference found in the surface inhibition of Beck's paste, after one hour's exposure, by using either 110 K.V. or 135 K.V., other factors being the same (Figs 1 and 2).

I am indebted and deeply grateful to Dr Frances A. Ford, who assisted me in looking up the literature on this subject. The only reference found was that of Pauli and Sulger, who mixed colloidal gold solution with agar (4). To this, bacteria were added and the mixture was poured in a plate. A

there must be some mistake in this experiment, or the ratio of the barium present was not great enough, or it is not the high atom-

thought it would be useless to attempt a similar experiment in meat. However, curiosity led me on, as, after all, I am per-

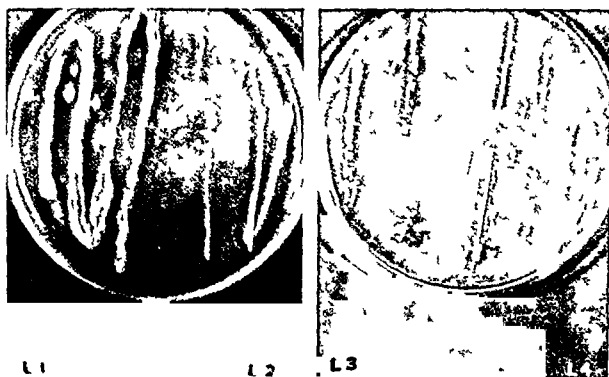


Fig 2 (first plate) Lipiodol L-1, Staphylococci mixed with lipiodol—control L-2, Staphylococci mixed with lipiodol for three hours—control L-3, Staphylococci mixed with lipiodol and treated with x-rays for five minutes L-4, Same staphylococci and lipiodol, treated for ten minutes

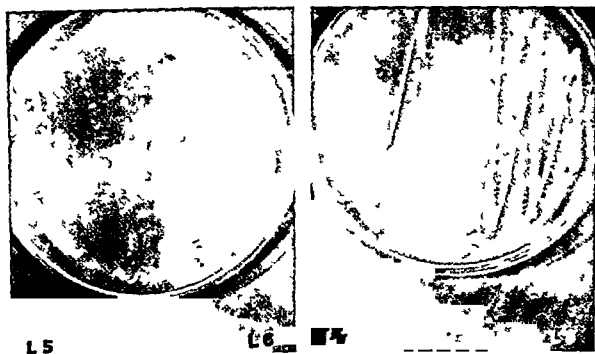


Fig 2 (second plate) Lipiodol L-5, Same mixture as shown in first plate, treated for thirty minutes L-6, Same mixture, treated for sixty minutes L-7, Same as L-6 L-8, Same mixture, untreated for sixty minutes—control X-ray factors same as used on Beck's paste

ic weight of the metal which is the controlling factor

A suspension of bacteria in salt solution was placed in a small well, 1 cm beneath the surface of paraffin, and exposed for one hour, with the following factors: 135 K V, 5 ma, 0 filter, and 10 in focal distance. This experiment was repeated six times, but no inhibition was obtained.

Because paraffin is of approximately the same density as the body tissues, I, at first,

sonally interested in the practical, more than the academic, application of this work. For this experiment in meat, I took a small gelatin capsule and coated it inside and out with paraffin in order that neither the juice of the meat nor the bacterial suspension in salt solution within should dissolve the capsule. I used a capsule in order that I might be sure of getting as many bacteria in the suspension at the end of the treatment as were present before it was started. The same fac-

is in these three substances which activated the x-rays, or is activated by the x-rays, is not proved. It is my opinion that the action is brought about through the secondary radiation emanating from the heavy metal present.

In view of these findings, we have at our disposal a means of treating deep-seated infections with sinus formation. We have a means of treating bronchiectatic lung abscess formation without surgery. And, finally, we have a means of explaining, at least in part, the beneficial results obtained from the x-ray treatment of skin infections. While bacteria are not completely inhibited even after one hour of exposure in the presence of meat, it is possible that they are stunned sufficiently to make it easier for the immunizing agents of the body to do their work. Just how true these conclusions are remains to be proved. I am reporting my work up to date in the hope that it will stimulate further work along this line of thought by men who have greater facilities and more

material with which to work. In the meantime, I shall continue the work myself and hope to have something more worth while to report at a later date.

SUMMARY

1. There is a marked inhibition of bacterial growth when bacteria are treated by x-rays in the presence of Beck's paste and lipiodol.
2. There is some inhibition of bacterial growth in the presence of meat after one hour of exposure to x-rays.
3. These findings warrant additional work to determine their practical value.

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THE CLINICAL SIGNIFICANCE OF DUODENAL STASIS¹

By SIDNEY A. PORTIS, M.D., CHICAGO

SO much has been written on this subject that one wonders what new can be added to the voluminous literature; however, as one follows this extensive subject, he is clinically impressed with the lack of emphasis and proper clinical interpretation that is placed upon temporary delay in the duodenum. I will not burden you with the well known causes of duodenal ileus, a subject that has seemed to take both internists and surgeons by storm, so to speak, nor will I review the definite roentgenologic evidence accompanying the prolonged delay and passage of chyme to the various portions of the duodenum, for this x-ray evi-

dence is better known to you than to me. What I am particularly interested in presenting is the clinical significance of the so-called temporary delay which can be more properly termed "stasis."

The physiology of this portion of the gastro-intestinal tract is not emphasized, nor is the biochemical phenomenon that ensues from temporary delay properly appreciated. The exact relation of gastric motility to duodenal motility is still a mooted question. Some hold that gastric movements end at the pyloric sphincter; others believe that at least in some cases the gastric wave of contraction passes down over the duodenum. In interpreting the facts on the relation of gastric motility to duodenal peristalsis, ac-

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, St. Louis, Nov. 30-Dec. 4, 1931.

portion of the plate was exposed to x-rays. The authors reported: "Colloids, through their secondary rays, increase the bactericidal effect of roentgen rays." A more

It is subject to criticism because one cannot always obtain the same amount of material in the platinum loop for subculturing. In spite of this, the fact that each experiment

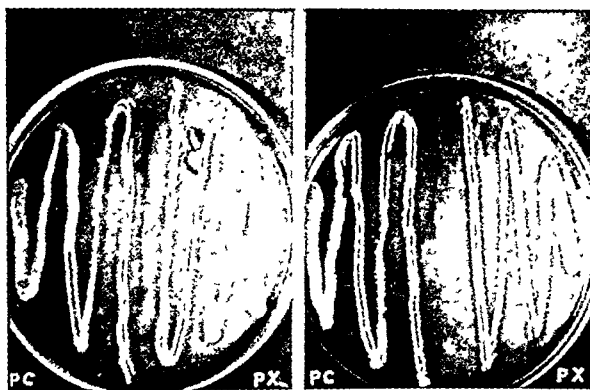


Fig. 2 (fourth plate). Miscellaneous. PC, Staphylococci suspended in normal salt solution after standing for one hour—control. PX, Same suspension as above, placed in a small well 1 cm. beneath the surface of paraffin and treated by x-rays for one hour. The same x-ray factors were used as for meat.

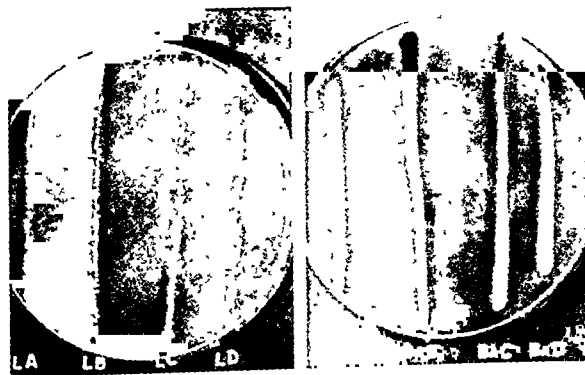


Fig. 2 (fifth plate). LA, Staphylococci mixed with lipiodol LB, Same mixture, after standing for one hour. LC, Same mixture, treated by x-rays (110 K.V., 5 ma., 0 filter, 10 in.) for one hour. LD, Same mixture, treated by x-rays (135 K.V., 5 ma., 0 filter, 10 in.) for one hour. BaA, BaB, BaC, BaD, Same as above, except that the staphylococci were mixed with barium sulphate suspension instead of lipiodol.

thorough search of the literature will be made and reported in a later paper, if any other work of this nature is found.

DISCUSSION

The technic used in these experiments does not provide for a determination of the percentage of inhibition in bacterial growth.

shows the same relative end-result on repetition warrants the conclusion that there is a decided inhibitory action on the growth of bacteria when they are treated in the presence of Beck's paste and lipiodol. Furthermore, there is evidence of some inhibition of bacterial growth when they are treated in the presence of meat. Just what the agent

pathologic physiology that necessarily accompanies it. Vomiting is more readily elicited from duodenal than from gastric irritation, and while the voluntary vomiting impulse caused by pharyngeal and gastric irritation may be inhibited, it is not so true of the duodenal type which is more rapid and violent in its onset. The observations of Burget (8) and of Graham (9) and his associates have shown that the tonus and motility of the duodenum play a fundamental rôle in the passage of bile from the gall bladder and biliary passages. It is not at all improbable that the hypertonus, amotility, and reverse movements of the duodenum may be important etiologic factors in disease of the biliary passages. I have become more and more convinced from my observations, both clinically and roentgenologically, that the early symptoms of cholecystic disease are primarily due to neuromuscular disturbances of the antrum, duodenal cap, and the second and third portions of the duodenum. Disturbances of this portion of the gastro-intestinal tract can easily account for the classical picture presented by early gall-bladder disease. However, when the disease takes a more chronic form, with its pericholecystitis and associated hepatitis, other factors enter into the clinical picture, which not only aggravate and modify the early symptoms but warrant surgical interference.

The secretions of the duodenum play only a minor rôle in digestion; however, the neutralizing ability of these secretions is very important. The duodenum is intimately related to the secretion of the stomach as well as to that of the pancreas. The duodenum can absorb substances from its lumen, such as water, glucose, alcohol, and crystalloids (potassium iodide and sodium chloride), quite rapidly. Because of the relatively rapid passage of the contents through and the incompleteness of the digestion of food when it enters the duodenum, probably a small amount of absorption occurs in the duodenum during the normal digestive pro-

cesses. In duodenal obstruction, toxic substances pass into the circulation from the lumen, which under normal conditions does not occur to a great extent. It is commonly stated that distention causes a disturbance or a breakdown in the normal processes concerned in absorption. Stimulation and irritation of the duodenum cause the patient to experience nausea, which is one of the most frequently observed symptoms elicited by duodenal stimulation. Pain is frequent in its occurrence and distention or spasm seems to cause it. Strouse (10) reported years ago that the distention of the duodenum with a balloon caused a similar sensation to that seen in the usual type of biliary colic. Uneasiness, faintness, dragging and swaying sensations, vertigo, chilliness, and pallor are other symptoms associated with duodenal irritation. Alvarez (11) has suggested reverse movements as the cause of nausea and vomiting; however, if these movements are not the cause of nausea, they are usually associated with nausea and vomiting elicited by duodenal stimulation.

Delay in duodenal evacuation from whatever cause may produce definite general changes, their severity depending upon the degree and duration of the obstruction. The resultant clinical, pathologic, and biochemical phenomena have received considerable attention from the experimentalists and, more recently, their proper evaluation from clinicians. It is well known that if allowed to go unchecked, these changes may result in severe toxemia, nervous syndrome designated as tetany, and even death. All investigators of this subject have agreed that these general changes are brought about by some toxic agent, the source of which is believed by many to be in the duodenum, the exact agent being unknown. Recent investigations of the acid-base equilibrium in pathologic conditions have been slowly adding to our knowledge of the factors involved in the maintenance of this equilibrium. Although the practical aspects of this problem

according to Ivy (1), at least four possibilities must be considered:

(1) Excitatory impulse or wave of conduction may pass from the stomach to the duodenum without the actual wave of contraction passing.

(2) The relative amotility of the cap, possibly due to anatomic relation and physiologic threshold of the relatively few contractile fibers of this portion of the duodenum, may mask the passage of the wave.

(3) The threshold of the mucosa or the musculature of the cap may be higher than the remainder of the duodenum so that greater distention, prolonged chemical action, or a summation of the local or transmitted stimuli may be necessary to cause the cap to contract.

(4) The duodenal peristalsis may be initiated almost immediately on the ejection of chyme from the stomach, due to the mechanical or chemical stimulation of the mucosa.

The observations of Wheelon (2) direct attention to another portion of the duodenum in which a tendency toward retention exists, namely, the inferior flexure. This is commonly the lowest point of the duodenum, and peristalsis must overcome the effects of gravity, lifting the contents to the fixed portion of the duodenum. Any extrinsic pressure on the fixed portion of the duodenum necessarily increases this delay. Hence, the tendency toward retention in the inferior flexure is relatively insignificant, with respect to the etiology of chronic duodenal dilatation, but does enter into the discussion of temporary duodenal stasis. The results of the experiments of Dragstedt and Dragstedt (3) show that the circular extrinsic pressure equal to six inches of water exerted by a light condom rubber band is sufficient to cause acute duodenal obstruction and death. An extrinsic pressure of less than six inches of water would lead to partial obstruction, with the usual concomitant phenomenon of hyperstalsis, dilatation, with some hyper-

trophy, intermittent nausea and vomiting, and mild toxemia.

Reverse movements of the duodenum occur under normal and abnormal conditions. They occur normally in many individuals at the end of a meal at the time chyme is being ejected into the duodenum. This is a well known fact. Such reverse motility may not only be due to enteric reflexes, but may occur by reflexes of the celiac ganglion. Reverse motility of the duodenum occurs abnormally in various conditions. Many have observed it in vomiting. Henderson (4) has reported reverse movements as present in 93 per cent of patients affected with hookworm. Friedman, Strauss, and Arens (5) have seen them in many patients with gallbladder disease and believe they are due to an associated duodenitis. Reverse movements of the duodenum will in all probability be associated with any condition that increases the motility of the duodenal mucosa or musculature. Brunemeier and Carlson (6) found that stimulation of the duodenum inhibits the motility of the emptying of the stomach. Wheelon and Thomas (7) observed that elevations of duodenal tone are associated with a reduction of gastric antral waves.

Although subject to the motor drive of the stomach, the duodenum possesses a mechanism for controlling this action, as shown by the observations cited. This is clinically manifested in the symptoms attributable to visceroptosis, with associated atony of the stomach. The relief or displacement of the stomach upward naturally encourages decreased duodenal stagnation and, therefore, automatically increases the gastric peristalsis. While it was formerly thought that the symptoms attributable to visceroptosis were those of reflex disturbances associated with a pull and drag on the various plexuses in the abdomen, we have now come to believe that the most important feature of visceroptosis is this apparent delay in emptying the duodenum and the associated

dioxide combining power, with an alkaline urine and the presence of normal acids in the stomach, I have found the liberal use of dilute hydrochloric acid after meals a valuable aid. This is not without long continued clinical experience, because many of the older clinicians in treating dyspepsia found that in giving hydrochloric acid after meals the patients showed improvement. They, however, knew nothing of the biochemical factors associated with dyspepsia.

Secondly, I have found that in a certain group of cases not associated with gall-bladder disease, in which the patients tolerate fats well, a ketogenic diet may bring about the desired result. This ketosis relieves the potential alkalosis, which is especially of value in cases of visceroptosis uncomplicated by gall-bladder disease, with associated duodenal stasis.

While this method of approach is not 100 per cent effective in all cases, I have been so clinically impressed with its results that I am reporting it at this time. My experience with a large number of cases of duodenal stasis is sufficient at the present time to allow me to draw some specific, as well as general, conclusions, which are as follows: (1) that the early symptoms of gall-bladder disease are associated with potential alkalosis; (2) that this alkalosis is a factor in producing distention, nausea, and belching, and when more marked, vomiting occurs; (3) that while the gall bladder may be a factor in producing temporary duodenal stasis, the symptoms that accrue to it are not due primarily to gall-bladder disease but to disturbance in the motility of the antrum, duodenal bulb, and second and third portions of the duodenum; (4) that if in early gall-bladder disease one can shift this potential alkalosis to an acidosis, definite relief may be seen in a large number of cases; (5) that if the peristalsis of the duodenum and the emptying of the duodenum are increased, it necessarily follows from the

physiologic facts outlined that the motility of the stomach is also increased (this is classically shown in cases of visceroptosis), and (6) that when duodenal ulcer and duodenal stasis or stagnation co-exist, as in a certain percentage of cases associated with gall-bladder disease or without gall-bladder disease, it would then seem rational that alkaline therapy would not be as effective as in simple uncomplicated ulcer, and this seems to be clinically true.

In this group of cases I have found it well not to use the ordinary types of alkalies but to substitute for them the tertiary salts of calcium and magnesium phosphate. The results have shown definite clinical improvement. Many patients who do not respond to ordinary alkaline therapy are thought to have stubborn ulcers, and in many instances gastro-enterostomy is performed. While the acidity of the duodenum is lowered, the factors concerned in producing a potential stasis in the second portion of the duodenum are not modified, and many patients still persist in their symptoms of nausea and associated phenomena. One wonders whether or not, in this particular group of cases in which stasis is very marked, duodenojejunostomy may not be the better surgical procedure.

Further, it is to be remembered that long continued alkaline therapy in these cases with duodenal stasis may so change the acid-base equilibrium to the alkaline side that it may lead to definite renal impairment.

I have purposely left out of this discussion chronic duodenal ileus, because its symptomatology and surgical treatment are well known to you. For the same reason I have also omitted the roentgenologic evidence. However, I want, particularly, to emphasize that many of the so-called neuroses of the upper abdomen, which have been called functional disturbances and which often give rise to many psychiatric problems, can in many cases be explained

are appreciated by the clinicians, the observations and discussions have concerned themselves in those cases in which equilibrium has been shifted to the acid side, this probably because of the greater frequency with which acidosis is encountered or recognized. Observations of upper intestinal obstruction indicate that an alkalotic condition of the body is as important as an acidotic state, if not more so. Gamble, Ross, and Tisdall (12) have shown that there is a regulatory mechanism in the body which tends to keep the fixed base in the blood constant, so that if salts of other acids are present in increased quantity in the blood, a migration of sodium chloride into the tissues occurs, leaving the fixed base relatively constant. It is a disturbance of this acid-base balance, produced by a toxic agent or agents, which results in the clinical syndrome, known as alkalosis, or alkalemia, and extreme manifestations, tetany, and death.

There is much experimental and clinical evidence to support this point of view. The derangement of the body chemistry is one of the outstanding features of duodenal intoxication. It includes changes of the blood, consisting of alteration in the plasma chlorides, the acid-base balance, and the non-protein nitrogen of the blood. These changes manifest themselves in a drop in the plasma chlorides, a shift of the acid-base balance to the alkaline side, as evidenced by an increase in the plasma carbon dioxide and the hydrogen-ion content of the blood. The nitrogen change is associated with a disturbance of the acid-base equilibrium of the kidney, necessarily raising the so-called renal threshold for its secretion.

It is possible to find first an acid urine in severe alkalosis, and it is probably associated with the presence of organic acids. Another finding that may be disconcerting is the presence of acetone bodies in the urine. While acetonuria is usually interpreted as indicative of acidosis, it has been shown that

a ketonuria may result from the administration of large doses of sodium bicarbonate. Morris (13) has shown that in experimental alkalosis produced in cats and dogs, alkalemia decreases the oxidation of arterial blood and still more greatly diminishes the amount of oxygen given up to the tissues. With this anoxymia it is conceivable that combustion of various food elements may be disturbed. Should this occur in the case of fats, the ketone bodies—evidence of incomplete fat combustion—may appear in the urine.

With the above physiologic and biochemical facts in mind, we can then consider that a potential alkalosis may accompany temporary duodenal stasis. It is on this basis that we can more readily explain the phenomena seen on fluoroscopic examination. However, the roentgenologist, knowing little of the clinical picture of the patient, is at a loss to put proper emphasis on these findings, and merely notes them in passing. There seems to be a definite lack of interest and also comprehension as to their importance. My interest in this subject is not purely one just of observation of associated symptoms with duodenal stasis.

In perusing the literature, both clinical and experimental, it is interesting to note that the references are made to a potential alkalosis but the suggestions for treatment are based purely on bed rest and diet. In many cases the patients have responded to this form of management. However, little emphasis is put on any additional medicinal therapy.

My observations of mild stasis within the last three years have impressed upon me the need for changing the acid-base equilibrium of the blood, an important factor in ameliorating this condition. I have chosen one of the two following methods, or both in some cases, depending upon the clinical picture of the patient. In these patients who show a very definite increase in the carbon

A SIMPLE INTEGRATING DOSIS MEASURING INSTRUMENT¹

By A. MUTSCHELLER, PH.D., NEW YORK

1. AN integrating type of X-ray dosis meter has advantages that are most valuable in clinical radiation therapy.

If errors are made in the adjustment of the usual constants, such as distance, tube current, voltage, filters, or even if changes in tube efficiency occur, they are either revealed during the treatment or they are accounted for in the total dosis applied to the skin. Hence the occurrence of skin injury or other damages, which in legal controversies are likely to be interpreted as avoidable carelessness, is totally avoided. However, if the reliability of such an instrument is lowered because it is unduly complicated or liable to get out of order, then its practical value is proportionally decreased.

2. A dosis meter is described here which offers some distinct advantages over those already in use. Several of the disadvantages of instruments of this type are eliminated through the use of a new type of trigger or "glow relay tube"² through which considerably more power for actuating the recording devices is obtained without the necessity of any further amplifying devices or radio tubes. Also the absence of tubes with filaments, and the elimination of storage batteries required to energize such filaments, is an advantage through which the reliability and ruggedness of the device are much increased.

3. The glow relay tube has three similar electrodes of thorium, which, however, are placed in a particular relation to one another. One electrode serves as common cathode for the other two. In series with the third electrode, the main anode is connected to the relay or other indicating or recording

device. The short distance between the cathode and the third thorium anode provides a small gap which is easily bridged by a discharge taking place when a definite positive voltage is applied to this starting, or relay, anode. At the moment discharge sets in, a larger discharge takes place between the main anode and the cathode and, therefore, the recording devices connected in series with that circuit respond and register. This tube, therefore, performs in every way the function of a relay or trigger device. The space within the bulb is prepared and evacuated so that a partial atmosphere of pure argon remains.

4. The radiation dosis is measured with an ionization chamber of the standard thimble type. It is to be calibrated in international r units by comparison with a standard ionization chamber and checked for wave length independence over the wave length range for which it is to be used.

5. The ionization current flowing through the chamber, which is proportional to the x-radiation intensity, is caused to accumulate upon the well insulated anode in the glower tube until a definite voltage has developed. The electrode is placed in proper proximity with a specially constructed negative electrode so that, at the moment when a definite voltage has been developed, there is set up in the glower tube an ionization discharge which initiates in it a separate circuit with the flow of an ionization current of sufficient magnitude to operate a relay and a counting or recording mechanism. Therefore, every time a certain definite quantity of radiation intensity has fallen upon the ionization chamber, the glower tube functions and an audible click is heard, with registering of the counting mechanism.

6. To compensate in the simplest man-

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

²RENTSCHLER, H. C.: *Trans. A.I.E.E.*, 1930, XLIX, 567.

on the basis of duodenal stasis of a mild or severe grade.

CONCLUSIONS

1. Duodenal stasis is either a definite entity or a part of a disturbed motility, associated with other disease in the abdomen, or the result of a mechanical factor, as in visceroposis.

2. The disturbed physiologic and biochemical phenomenon that ensues explains many of the symptoms attributable to it.

3. Changing a potential alkalosis to that of an acidosis brings about in many cases relief of the symptoms.

4. What has been called abdominal neurosis for the most part is often associated with temporary delay in the duodenum.

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DISCUSSION

DR. HORACE W. SOPER (St. Louis, Mo.): The treatment of this condition has been very unsatisfactory, I am sure, in most of our hands. We have had a number of cases in which we have proved that duodenal stasis was produced by adhesions. We have secured very good results by operative treatment in releasing the adhesive bands binding down this portion of the duodenum. Again in viscerop-

osis, particularly the acquired form, the distasis of the lower recti muscles leads to duodenal stasis which is benefited by proper abdominal support.

One of our patients, who had had a pyloroplasty for ulcer, was left with quite a large dilated duodenum and considerable stasis. She presented the classical symptoms of duodenal stasis. Finally an entero-anastomosis was done and adhesions were found to account for the tremendous dilatation of the duodenum. The entero-anastomosis was not successful, and the patient had recurrent attacks of this toxic condition. Finally we resorted to the time-honored remedy that, I believe, is used only in the Southern States and in the Mississippi Valley, namely, giving a dose of calomel periodically every two weeks, followed in the morning by a good dose of the double salt of magnesia and sodium sulphate. The woman is now getting along fairly well. I may have the opportunity of trying out on this patient the new treatment suggested by Dr. Portis.

DR. PORTIS (closing): I purposely omitted taking up the question of cases of adhesions or duodenal ileus that are primarily surgical, because most physicians to-day are agreed that duodenojejunoscopy should be performed in chronic duodenal ileus producing a disturbed emptying time of the stomach. With ordinary methods of therapy patients presenting stasis continue to have their symptoms, and I wanted to emphasize that particular phase of the subject.

I quite agree with Dr. Soper when he says the time-honored remedy of giving purgatives and calomel will sometimes produce results. But it is to be remembered that anything that stimulates the duodenum stimulates the small intestine and the large intestine, causes an earlier emptying of the duodenum, and, naturally, relieves this so-called temporary stasis. Purgation effects the same result as the giving of hydrochloric acid to induce a more rapid emptying of the duodenum, but the latter does not disturb the rest of the gastro-intestinal tract, and I think it is a much more physiologic and superior method.

A SIMPLE INTEGRATING DOSIS MEASURING INSTRUMENT¹

By A. MUTSCHELLER, PH.D., NEW YORK

1. AN integrating type of X-ray dosis meter has advantages that are most valuable in clinical radiation therapy.

If errors are made in the adjustment of the usual constants, such as distance, tube current, voltage, filters, or even if changes in tube efficiency occur, they are either revealed during the treatment or they are accounted for in the total dosis applied to the skin. Hence the occurrence of skin injury or other damages, which in legal controversies are likely to be interpreted as avoidable carelessness, is totally avoided. However, if the reliability of such an instrument is lowered because it is unduly complicated or liable to get out of order, then its practical value is proportionally decreased.

2. A dosis meter is described here which offers some distinct advantages over those already in use. Several of the disadvantages of instruments of this type are eliminated through the use of a new type of trigger or "glow relay tube"² through which considerably more power for actuating the recording devices is obtained without the necessity of any further amplifying devices or radio tubes. Also the absence of tubes with filaments, and the elimination of storage batteries required to energize such filaments, is an advantage through which the reliability and ruggedness of the device are much increased.

3. The glow relay tube has three similar electrodes of thorium, which, however, are placed in a particular relation to one another. One electrode serves as common cathode for the other two. In series with the third electrode, the main anode is connected to the relay or other indicating or recording

device. The short distance between the cathode and the third thorium anode provides a small gap which is easily bridged by a discharge taking place when a definite positive voltage is applied to this starting, or relay, anode. At the moment discharge sets in, a larger discharge takes place between the main anode and the cathode and, therefore, the recording devices connected in series with that circuit respond and register. This tube, therefore, performs in every way the function of a relay or trigger device. The space within the bulb is prepared and evacuated so that a partial atmosphere of pure argon remains.

4. The radiation dosis is measured with an ionization chamber of the standard thimble type. It is to be calibrated in international r units by comparison with a standard ionization chamber and checked for wave length independence over the wave length range for which it is to be used.

5. The ionization current flowing through the chamber, which is proportional to the x-radiation intensity, is caused to accumulate upon the well insulated anode in the glower tube until a definite voltage has developed. The electrode is placed in proper proximity with a specially constructed negative electrode so that, at the moment when a definite voltage has been developed, there is set up in the glower tube an ionization discharge which initiates in it a separate circuit with the flow of an ionization current of sufficient magnitude to operate a relay and a counting or recording mechanism. Therefore, every time a certain definite quantity of radiation intensity has fallen upon the ionization chamber, the glower tube functions and an audible click is heard, with registering of the counting mechanism.

6. To compensate in the simplest man-

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

²RENTSCHLER, H. C.: *Trans. A.I.E.E.*, 1930, XLIX, 567.

ner for all possible variations, there is provided a radiation standard which can be switched into the circuit in place of the ionization chamber. Furthermore, a variable condenser is provided for the purpose of ad-

is to be placed near the patient at a suitable height so that the ionization chamber rests on the part to be irradiated or treated. This is easily accomplished with the aid of a special rack and pinion movement oper-

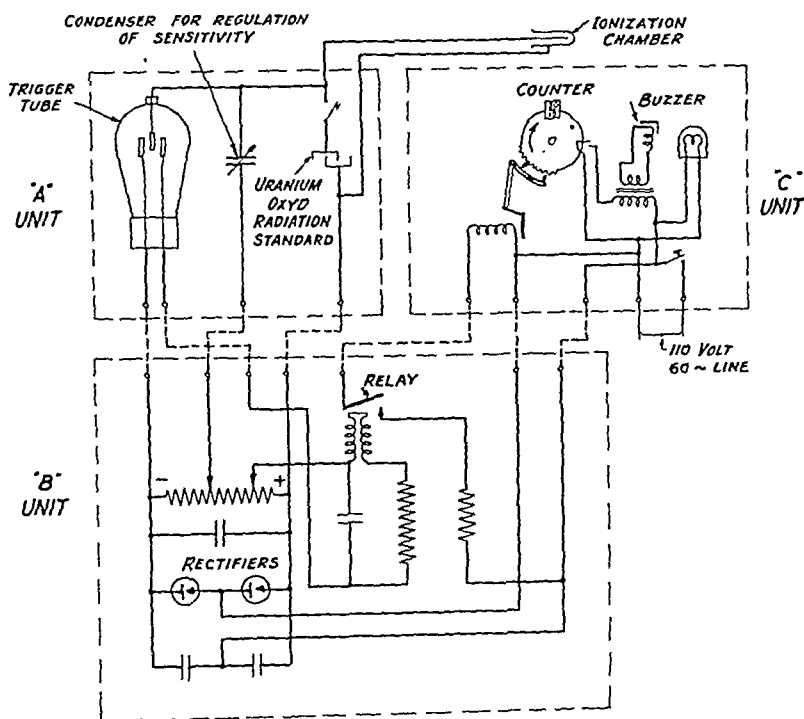


Fig. 1. Schematic diagram of the glow relay tube as used in the integrating dosimeter.

justing the sensitivity of the device. Hence, to make a complete adjustment of the instrument, the condenser is varied until, with the uranium oxide standard switched in, the time interval between clicks is the same as that for which the instrument is calibrated. Of course, adjustment is made while no X-rays fall upon the ionization chamber, and so abnormal factors leading to errors, such as abnormal voltage on the ionization chamber or the glower tube, leakage, etc., are either immediately discovered or they are adequately compensated for by the adjustment.

7. The circuit and structural details of the glow relay tube are shown schematically in Figure 1. The parts grouped within the dotted line and marked "A Unit" are mounted and assembled in an apparatus that

is to be placed near the patient at a suitable height so that the ionization chamber rests on the part to be irradiated or treated. This is easily accomplished with the aid of a special rack and pinion movement oper-

ated with a crank handle. A single cable containing three wires connects from this unit to the part marked "B Unit."

8. The box housing "Unit B" contains a small transformer, valve tube, chokes, and condensers to generate from ordinary A.C. house lighting current, the direct current voltage required for the ionization chamber and the glow relay tube. In this unit, which is conveniently placed near the control board and the operator, there are also a relay and counting device with an indicating dial which is located on the front panel of the box.

9. For practical use, the instrument is connected to the power supply line and then, while no X-rays fall upon the ionization chamber, the uranium oxide standard is switched in. The time interval between the

clicks is measured with a stop watch. If the time between clicks is not the same as that determined for the particular uranium oxide standard by calibration, then the variable condenser is either increased to make the time between the clicks longer, or decreased if the clicks occur too frequently. After this adjustment is made, the uranium oxide standard is switched out and the instrument is used for measuring the X-radiation dose.

10. The usual calibration of the instrument is based upon the fact that between any two clicks, a current of three (or five) electrostatic units per unit volume is passing through the ionization chamber. These, then, correspond to a radiation intensity of three (or five) r units under standard conditions of pressure and temperature. Therefore, the total treatment dose is divided by three (or five) to find the number of clicks, or the number of changes of the figures on the counting device, required to make up the dose.

11. The integrating dosis measuring de-

vice is presented because it possesses the advantage of much greater simplicity, compactness, and ruggedness over the instruments now in use for a similar purpose. Greater reliability is secured in measuring the dose applied directly to the skin of the patient and, in general, there is less danger of errors and accidents.

DISCUSSION

DR. E. A. POHLE (Madison, Wis.): I am very much in favor of the development of an integrating dosimeter which is simple, rugged, reliable, and foolproof. I believe the ideal method of applying X-rays accurately is to place a chamber on the patient and to record the dose during the entire treatment, not using the method of dosing by time.

DR. ROY KEGGEREIS (Chicago, Ill.): Dr. Mutscheller and his associates should be congratulated on having brought out this "click" instrument. Its use involves the element of time, one has to wait a little bit, and it is not an indicating instrument, but I am quite sure it will appeal to radiologists. It is simple in operation and has a tremendous range in sensitivity.

X-RAY IN THE DIAGNOSIS OF RENAL TUMORS AND POLYCYSTIC KIDNEYS¹

By JOHN R. CAULK, M.D., Professor of Clinical Urology, Washington University,
SAINT LOUIS

NINE years ago, it was my privilege to speak before this Society on the relation of radiology to urology and to welcome the partnership existing between our two branches of medicine. To-day we find this bond even closer. This close affiliation is particularly essential in the radiologic diagnosis of renal tumors and polycystic kidneys.

It is manifest that either urology or radiology alone is inadequate to explain the diagnostic intricacies of renal tumors, and even their combined efforts occasionally fall short, the aid of other general and special

studies being sought. Many of these, however, are dependent upon the x-ray and demand complete gastro-intestinal configuration and cholecystography, as well as general skeletal studies and roentgen-ray examination of the chest for metastatic changes. Study of the genital tract in male or female may disclose the primary cause of some vague abdominal or retroperitoneal tumor. Provided all renal neoplasms uniformly presented the symptom-complex of tumor, pain, and hematuria, the task of diagnosis would be simplified, but only one-third of the cases record all three, hence the need for detailed study.

My listeners' familiarity with this subject

¹Presented before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

makes it extremely difficult for me to offer any novel features; hence in this presentation I can do no more than refresh your memory with some of the standard facts in diagnosis and possibly suggest a few points which may elicit discussion.

Thoroughly to differentiate renal tumors, it is necessary to consider not only new-growths of the kidney but other pathologic processes such as severe infections (with or without calculus), tuberculosis, parasitic diseases, large hydronephroses, abnormal movability, and congenital malformations which may bear a close resemblance to neoplasms. The larger growths often require accurate differentiating from gall-bladder and splenic conditions, intestinal tumors and retroperitoneal masses. Again, we must be equally alert to the changes in the pelvic outline in cases presenting symptoms suggestive of tumor but without visible or palpable evidence of the growth, such as those occurring from small neoplasms invading a localized area of the kidney substance and pelvis, tumors within the pelvis, and filling defects produced by less serious causes such as those created by spasm, soft stones, aberrant vessels, granulomas, and vascular changes. Both groups offer many complex problems.

Since we are dealing with the value of radiology in the diagnosis of such tumors, other diagnostic aids will receive no comment, assuming, of course, that a thorough medical investigation has been made. The size, contour, presentation, location, and the relation to other viscera, particularly the bowel, are helpful aids, but ultimately the combined efforts of urologists and radiologists are necessary for the differentiation of abdominal tumors. The plain x-ray, the so-called flat plate, may outline the growth and suggest it to be a renal shadow; however, an enlarged kidney shadow must not be relied upon too strongly as indicating a growth, since other factors, such as the size of the patient, the amount of fat, the type of exposure, the distance from the film, etc.,

may create this apparent enlargement. Very large tumors are seldom definitely outlined. The demonstration of shadows within the kidney regions strengthens the diagnosis of kidney disease, but the possible presence of an overlying gall bladder, with stones, must always be borne in mind. Scattered indefinite shadows within the outline of a large growth are highly suggestive of calcification of a renal tumor. Tuberculosis may show a similar picture, and frequently soft calculi, calcifications, or inspissated pus in a pyonephrotic kidney, as well as calcification of glands, may be confusing. In symptomless renal tuberculosis there is a tendency for the calcification to be more pronounced.

Since there is no specific pelvic picture of a renal tumor and the pyelographic evidence depends upon the part of the pelvis invaded and distorted, one has to be extremely careful in its interpretation and no individual is capable of always making a positive assertion that tumor is present, in cases showing slight aberrations from the normal. Careful rechecking of such pyelograms must be done and the clinical picture must fit with the findings. Repeated studies are required. Localized substance tumors may occur without any interference with pelvic contour even in large growths of one or the other pole, and only change of pelvic position will tell the story.

The character of the deformity will naturally depend upon the part of the pelvis involved and may vary from a small exclusion of a part of a calyx to complete occlusion of the pelvis; the latter would be difficult to differentiate from a tuberculous renal occlusion were it not for other clinical factors. Even the localized lesions tending to amputate a calyx may find an almost similar reflection in certain tuberculous involvements; but when tumor isolates a calyx it is usually complete or the shadow diminishes from the pelvis to the cortex, whereas in tuberculosis complete isolation is seldom present and a partial one shows the narrow fillings

nearer the pelvis, with a tendency toward dilatation distal to it, due to abscess formations. Such dilatations do not occur in tumor. The changes in the ureter occurring in tuberculosis, as well as cystoscopic evidences of the disease in the bladder, assist in clearing the diagnosis.

In large growths involving the whole organ, the pelvis may be tremendously elongated and thinned out and even broken in its course, forming streaks of bizarre shape—the spider-leg pelvis, for example.

In large tumors involving the lower pole there is a tendency for the pelvic position to be lowered through traction. The course of the ureter is interfered with, being usually deflected inwardly with a rounded sweep across the spine. Smaller growths may interfere with the ureter but little through pressure, and produce only a slight kinking near the pelvis. Tumors of large size involving the upper pole are more likely to be fixed; the pelvic outline may not be so markedly depressed as in lower pole tumors, and rotation is less likely. The most pronounced pelvic rotation seems to appear in tumors originating below the mid-section of the kidney.

In differentiating large tumors of the liver, gall bladder, spleen, or bowel from renal neoplasms, one is often faced with a real task; yet, correlated with the general clinical picture, there are urologic and radiologic evidences which are definite. Tumors of the liver, gall bladder, and spleen seldom disturb the relationship of the renal pelvic outline and only occasionally distort the ureteral picture. In two instances I have seen large gall-bladder tumors carry the ureter inward, as is seen in large lower pole tumors of the kidney or in retroperitoneal growths, but this, in my experience, has been exceptional. The same applies to the spleen. Hence, if the pelvic outline remains apparently normal or slightly hydronephrotic, the growth is extra-renal.

In retroperitoneal growths, ureteral dis-

placement is most pronounced. There is a tendency for an inward sweep over the spine, its length depending upon the size of the tumor; its outline is generally smooth unless disturbed by inflammatory adhesions or malignant involvement from the growth. The pelvic outline is either normally posed or occupies a higher position, depending upon the size of the growth, but shows no infringement or very little in proportion to the size of the tumor. If the ureter is involved, hydronephrosis may result. Gastro-intestinal radiography is then of paramount importance. Hepatic tumors depress the transverse colon; renal tumors rarely do. Splenic tumors tend to deflect the stomach and colon downward and inward. Renal tumors of large size, owing to their retroperitoneal position behind the ascending or descending colon, carry these structures inward, hence the evidences afforded by urographic studies coupled with information secured by gastro-intestinal radiology will usually suffice to localize the source of the tumor.

A tremendous retroperitoneal lipoma recently examined presented presumptive evidence of renal tumor; indeed, almost typical by palpation. Associated gastro-intestinal and urologic studies disclosed the tumor to be of extra-renal origin.

Congenital anomalies of the kidney occasionally offer diagnostic difficulties and may be confused with renal neoplasms, prominent among which are the large unilateral fused kidneys, horseshoe kidneys, abnormally large kidneys with double pelves, the so-called *double kidneys*, occasionally *ectopic kidneys* with pathological changes within them, and particularly polycystic disease of these organs. Tumors, of course, may occur in any of these anomalous kidneys; I have, however, never observed one in the polycystic organ. These conditions can be differentiated without difficulty through systematic uroradiologic studies.

From this realm of renal anomalies, poly-

makes it extremely difficult for me to offer any novel features; hence in this presentation I can do no more than refresh your memory with some of the standard facts in diagnosis and possibly suggest a few points which may elicit discussion.

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TREATMENT OF CARCINOMA OF THE THYROID GLAND¹

By JOHN DEJ. PEMBERTON, M.D., Division of Surgery, and ROBERT E. FRICKE, M.D.,
Section on Therapeutic Radiology, The Mayo Clinic, ROCHESTER, MINNESOTA

OUR purpose in this study is to come to a conclusion, if possible, concerning a rational method of treatment of carcinoma of the thyroid gland, giving due consideration to the type of carcinoma and its stage of advancement. Our conclusions will be based on comparison and evaluation of different methods of treatment which have been employed in the Mayo Clinic.

Carcinoma of the thyroid gland is unique among the malignant tumors. It arises, as a rule, in long-standing adenomatous nodules. As most writers on the subject have emphasized, it is impossible to recognize by clinical examination the early malignant changes. When the process has advanced sufficiently to permit of clinical diagnosis, any operation, except for palliation, is commonly of little avail. The rich blood supply of the gland and the proximity to the large cervical veins and lymphatic structures favor early metastasis, involving the regional nodes, lungs, bones, brain and other viscera. This peculiarity is so readily recognized now that discovery of a malignant bone tumor or of a carcinoma in a lung or other organ usually impels careful examination of the thyroid gland as a possible primary site of the growth. In some cases, carcinoma of the thyroid gland is first suspected after the finding of distant metastatic growths. Wilson (10) stated that correct early diagnosis of carcinoma of the thyroid gland is made less frequently than that of malignancy of any other organ.

Owing to the diversity of the histologic features of carcinoma of the thyroid gland and to their similarity to benign changes seen in the gland in response to various

stimuli, pathologic diagnosis may be exceedingly difficult, even to trained pathologists. In 1924, from a study of a large series of carcinomas of the thyroid gland, Graham (4) pointed out the frequency with which carcinomatous cells actually invade the blood vessels, and concluded that this finding offered a more reliable criterion of carcinoma in certain types of tumors of the thyroid gland than did histologic cellular changes. Although most pathologists agree that the finding of invasion of vessels is evidence of malignancy, many do not depend on this to establish the diagnosis. They maintain that cellular invasion is not a constant feature of all types of malignant tumors of the thyroid gland; hence, for diagnostic purposes, absolute dependence cannot be placed on this feature. Instead, histologic cellular changes are considered to be more trustworthy.

Carcinoma of the thyroid gland occurs in three distinct types: (1) Papillary adenocarcinoma; (2) adenocarcinoma in adenoma, and (3) diffuse scirrhous adenocarcinoma. A fourth group may be added, namely, spindle-cell carcinoma resembling sarcoma. These vary widely, both in degree of malignancy and in their tendency to metastasize to distant organs. Of necessity, the results of any form of treatment vary with the types of carcinoma, which have been named practically in the order of their degree of malignancy; for instance, papillary adenocarcinoma is of a low grade malignancy and grows slowly, metastasis being almost limited to the regional nodes. The spindle-cell type, fortunately rare, grows speedily, produces distant metastasis, and is almost without exception rapidly fatal.

Before the advent of irradiation, operation was the only means of combating the

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

cystic disease is our chief concern, since it may closely simulate a neoplasm. While this disease has a tendency to be bilateral, only one kidney may present noticeable evidence of growth, and, like renal tumors, may be associated with pain and hematuria. Clinical studies and our concerted efforts will generally solve the diagnosis. The pyelographic changes of a polycystic kidney may be variable, but they follow a much more characteristic course than do renal tumors. There is usually great lengthening of the calices and, with it, one seldom observes the fine linear streaks from compression such as are seen in renal tumors. The general outline of the calices is smooth in the infundibular areas. The distal parts of the calices show a decided tendency to dilatation, while the pelvis is distorted throughout its outline, in contradistinction to the pelvis of the renal tumor which may be normal in one portion and completely disrupted in the other. Since the disease is so frequently bilateral, the pelvis of the mate will usually show similar disturbances. Such pelves cover more territory than any other type unassociated with general dilatation.

There is probably no more perplexing problem in radiologic study than the second group previously alluded to, namely, cases presenting evidences of renal tumor but without demonstrable growth. Here one is confronted with hematuria of renal origin, defective pelvic filling by pyelographic studies—usually without blood dyscrasias or disturbance of renal function. Small tumors involving a localized area of kidney infringing on a part of the pelvis or calices, require extreme care in diagnosis. Besides having to be differentiated from tuberculosis, as previously mentioned, equal scrutiny is required in ruling out such lesions as soft shadowless pelvic stones, filling defects of the pelves from muscle spasm, changes due to aberrant vessels, granulomas and the like, and particularly from clots resulting from idiopathic renal epistaxis. In such instances

information secured from pyelograms taken during the process of hematuria is often deceptive—a small blood clot may be confusing. Such pyelograms must always be rechecked between bleedings. I have observed a number of cases with definite filling defects in the true pelvis and calices which showed no such evidence after bleeding had ceased. On the contrary, I have observed equal filling defects present themselves at the time free from bleeding, and, on rechecking, have noted their disappearance. Insufficient filling of a calyx, spasm of a calyx or a part of the pelvis which may be physiologic must always be taken into consideration and can only be proven by careful re-investigation. Persistent defects within the pelvis or calices may represent granulomas, papillary tumors of the pelvis, or soft calculi, and, if symptoms persist or recur, exploration is required. Topographical changes in the ureter, associated with filling defects in the pelvis, often offer corroborative evidence of tumor, owing to the pronounced tendency of papillary tumors of the pelvis to transplant in the ureter.

We are probably of one accord in urging repeated studies in such problematical pelves, and are familiar with the physiologic changes due to smooth muscle contraction as they vary from systole to diastole, and simulate localized defects.

I have been definitely impressed with the fact that intravenous urography in the differential diagnosis of renal tumors offers less reliable evidence than does retrograde pyelography, since the detailed configuration is less accurate, and, furthermore, as is the case in most renal diseases, the ureteral catheter is required not only to secure the urinary constituents from each kidney but to properly determine their comparative functions.

The proper correlation of radiology and urography will definitely prove the existence of renal growth or polycystic disease in the majority of cases.

TABLE I.—TREATMENT OF 161 CASES OF CARCINOMA OF THE THYROID GLAND

Group	Cases	Percent-age	Treatment
Surgical (107)	50	46.73	Surgery and radium
	12	11.21	Surgery and roentgen rays
	35	32.71	Surgery, radium, and roentgen rays
Non-surgical (54)	10	9.34	Surgery only
	15	27.78	Radium only
	6	11.11	Roentgen rays only
	33	61.11	Radium and roentgen rays

benign adenoma of the thyroid gland frequently arises. Since from 80 to 90 per cent of carcinomas of the thyroid gland arise in pre-existing benign adenomas, and in view of our inability to detect clinically early malignant changes in a nodular goiter, because of the high mortality of carcinoma of the thyroid gland in general, and the small operative risk in removal of simple adenomas, we believe that operation should be seriously considered as the treatment of choice for all adenomatous goiters.

The group selected for study consists of 161 patients treated at the Mayo Clinic from 1921 to 1926, inclusive. They were chosen to enable us to determine remote results of treatment over a period of from five to ten years. Actually, 213 cases of carcinoma of the thyroid gland were seen in this interval of six years, but 52 cases are not included, for the patients returned home for treatment following diagnosis at the clinic. The 161 cases reviewed are separated into a "surgical" group, in which treatment was by operation and irradiation, and a "non-surgical" group, in which only irradiation was given. The incidence of carcinoma of the thyroid gland is usually quoted as from 1 to 6.75 per cent (3, 9) of all cases in which the thyroid gland is the primary site of disease. In this period of six years, of 11,175 operations for goiter performed at the Mayo Clinic, carcinomas were found in 107 (0.96

TABLE II.—END-RESULTS IN 51* NON-SURGICAL CASES OF CARCINOMA OF THE THYROID GLAND

Length of life after treatment	Dead	Per-centage	Living	Per-centage
Less than 1 year	28	54.90		
1 year and more	8	15.69		
2 years and more	3	5.88		
3 years and more	3	5.88		
4 years and more	2	3.92		
5 years and more	1	1.96	1	1.96
6 years and more			2	3.92
7 years and more	1	1.96	1	1.96
8 years and more				
9 years and more			1	1.96
Total	46	90.19	5	9.80

*Three of the 54 patients who composed this group could not be traced, but were living when last heard from.

per cent). The incidence in the non-surgical cases cannot be accurately determined, due to lack of biopsy in many of them.

In the non-surgical group of 54 cases, females predominated in a ratio of 1.34 to 1. The average age of the females was 51.90 years and of the males 53.13 years. This medical group comprised the hopelessly advanced, inoperable cases. In the surgical group of 107 cases, there was a still greater preponderance of females—the ratio was 3.28 to 1. The average age of the females was 43.27 years, and of the males, 50.88 years.

On analyzing the type of treatment given (Table I) it was found that, in the surgical group of 107 cases, operation and irradiation were employed in all but 10 cases (9 per cent). This small group of 10 cases, in which treatment was by surgery without irradiation, was not studied separately in compiling results, for reasons that will appear. Irradiation was omitted in three cases because of post-operative death: from surgical shock in one case, from post-operative pneumonia in a second, and from hemo-

disease. Results were not encouraging. In 1921, Wilson, reviewing all the literature on malignant tumors of the thyroid gland to that date, expressed his belief that one reason why relatively few cases were reported was the reluctance of anyone to report cases in which his treatment was futile. In advanced, inoperable conditions, palliative operation and sedatives were the only methods of relief available. The literature gradually increased. Herbst (5) reviewed surgical results at the Mayo Clinic up to 1921, and Pemberton (6) reported results at the same institution up to 1924. In the meantime, radiologists found that palliation could be obtained in advanced cases, with occasional cures, and that post-operative treatment secured better results than surgery alone. In this country excellent results were reported by Bowing (2), Pfahler (7), Portmann (8), and Craver (3), to mention only a few. Leading radiologists in Germany maintained that carcinomas of the thyroid gland are markedly radiosensitive (3).

The principles of treatment of carcinoma of the thyroid gland, as followed in the Mayo Clinic, have varied with the type of malignancy and the degree of involvement. We consider operable those cases without marked fixation to surrounding structures by invasion and without metastasis. On operation, the carcinoma is found to be confined within the capsule. In these early cases, removal of all the growth without rupture is ample; removal of further thyroid tissue is unnecessary. If, however, the carcinoma is not definitely encapsulated, total removal of the affected lobe, for these growths are usually confined to one lobe, is indicated. With late cases, further invasion and some degree of fixation of the tumor has occurred; metastasis may or may not be present. If, at operation, the growth can be removed, complete extirpation of the lobe is indicated, with subsequent irradiation. On

exploration, if the local growth is found to be too adherent or fixed for resection, radium needles may be buried, 1 cm. apart, in the tumor. The needles we prefer now contain 1 mg. each, and the filter is 0.4 mm. of platinum. Silk threads are attached to the needles, so that the surgical wound may be closed, and the needles removed aseptically from 24 to 48 hours later. During the years reviewed in this study, we employed stronger needles, containing 5 mg. of radium filtered through steel alloy. These were placed 1 cm. apart and were left in place for a shorter time, usually from 14 to 24 hours.

Further external irradiation is given later during the convalescent period. In all surgical operations, whether early or late, a large rubber drainage tube is left in the cavity so that radium, on a lead stem, may be inserted into the depths. A 50-mc. tube of radon in a silver applicator is left in place for a dosage of from 200 to 400 millicurie-hours. During convalescence, external irradiation is also given. External irradiation may be given in all cases post-operatively, and also in the inoperable cases. This consists of checker-boarding the region of the thyroid gland in fields about 3.25 cm. square. The frontal and lateral regions of the neck are thus marked, and to each area, at a distance of 2.5 cm., 50 mg. of radium are applied, using three areas at a time, until the whole surface is treated and is given a mild erythema dose. At present, radium only is used in this fashion if pathologic examination has given evidence of lesions graded 1 or 2. For growths graded 3 and 4, supplementary high voltage roentgen treatment is given through a dorsal field. In the series here reported, moderate voltage roentgen rays were used until about the year 1924, when use of higher voltages became more frequent. Roentgen therapy was also applied to all distant metastatic growths.

Furthermore, the question of treatment of

long standing, and growth had been noted for more than four years in the average case. The cases in the non-surgical group were advanced and inoperable, permitting clinical diagnosis. The growth of the pre-existing goiter averaged less than three years. Disregarding fractions, 61 per cent received treatment by both radium and roentgen rays; 28 per cent received treatment by radium only, and 11 per cent by roentgen rays only. In 31 of the 54 cases (57 per cent), biopsy was made.

The end-results in these advanced, non-surgical cases (Table II) treated by irradiation only were rather disappointing. We were able to trace 94.44 per cent of the 54 patients who were treated by irradiation only. Of these, 54 per cent died within the first year. Of the patients traced, five, or roughly 10 per cent, are still living: one for five years, two for six years, one for seven years, and one for nine years following treatment. Forty-six (90 per cent) are known to be dead. Biopsy was obtained, fortunately, in all of the cases in which patients are living. Two of the growths were papillary carcinomas, two were carcinomas in adenoma, and one was a diffuse adenocarcinoma. Two were of Grade 1 and three were of Grade 2.

The surgical group of 107 cases presented an entirely different picture (Table III). We were able to trace 91 patients (85.05 per cent). Of these, 58 (63.74 per cent) are still living and apparently well for from five to ten years after treatment. Thirty-three (36.26 per cent) have died. Of the 16 patients not accurately traced, approximately 15 per cent of the group, all were living when last heard from: two for nine years and more; two for seven years and more; two for six years; two for four years; four for three years; two for two years; one for a year, and one for less than a year since treatment.

We are indebted to A. C. Broders and

W. H. Bueermann for the pathologic studies in this series of cases. Most of our surgical cases fall into the class of papillary adenocarcinoma or carcinoma in adenoma (so-called malignant adenoma). Both of these are usually of low grade malignancy, graded 1 or 2. The grade of malignancy of papillary adenocarcinomas is very low. As mentioned before, distant metastasis of these growths is uncommon; local extension to the cervical glands may occur, but recurrence is infrequent, permitting more radical operation, and the tumors are distinctly radiosensitive. The higher grades of malignancy are exemplified by diffuse adenocarcinoma and spindle-cell carcinoma resembling sarcoma. Fortunately these types are less common.

Among our 107 surgical cases, in 32 (29.91 per cent), the tumors were papillary adenocarcinomas; in 66 (61.68 per cent), carcinomas in adenoma; in six (5.61 per cent), diffuse adenocarcinoma, and in three (2.8 per cent), spindle-cell carcinoma resembling sarcoma. Taken by graded malignancy, the growths in 34 cases were of Grade 1; in 52 cases, of Grade 2; in 12 cases, of Grade 3, and in nine cases, of Grade 4. In our group of non-surgical cases, biopsy was made in 31 cases. In 10 cases, the tumors were papillary adenocarcinomas; in seven, carcinomas in adenoma; in nine, diffuse adenocarcinomas, and in five, spindle-cell carcinomas resembling sarcoma. Considered by grades of malignancy, the growths in seven cases were of Grade 1; in nine cases, of Grade 2; in five cases, of Grade 3, and in 10 cases, of Grade 4. The tendency here was definitely toward the higher grades.

Among the 58 patients of our surgical group who are still living (Table IV), the tumors of 25 (43.1 per cent) were papillary adenocarcinomas, and of 31 (53.45 per cent) carcinomas in adenomas. In only one case was the neoplasm a diffuse adenocarcinoma

TABLE III.—END-RESULTS OF 107* SURGICAL CASES OF CARCINOMA OF THE THYROID GLAND

Length of life after treatment	Classified by grade of malignancy										Classified by histologic type						
	Grade 1, cases		Percent- age**	Grade 2, cases	Percent- age	Grade 3, cases	Percent- age	Grade 4, cases	Percent- age	Papillary adeno- carcinoma	Carcinoma in adenoma		Diffuse adeno- carcinoma		Spindle-cell carcinoma resembling sarcoma		
	Cases	Percent- age	Cases	Percent- age	Cases	Percent- age	Cases	Percent- age	Cases		Percent- age	Cases	Percent- age	Cases	Percent- age		
Less than 1 year				5	9.62	2	16.67	5	55.55								
1 year and more	1	2.94		1	1.92	1	8.33					8	12.12	2	33.33	2	66.67
2 years and more	1	2.94		2	3.85							3	4.54				
3 years and more	1	2.94		8	15.38	1	8.33	1	11.11	2	6.25	4	6.06				
4 years and more	3	8.82		2	3.85	2	16.67			3	9.37	4	6.06				
5 years and more	7	20.59		9	17.31	3	25.00	1	11.11	5	15.62	13	19.70	2	33.33		
6 years and more	6	17.65		11	21.15	1	8.33			8	25.00	9	13.64	1	16.67		
7 years and more	4	11.76		7	13.46	2	16.67	1	11.11	5	15.62	8	12.12			1	33.33
8 years and more	3	8.82		3	5.77					2	6.25	4	6.06				
9 years and more	7	20.59		3	5.77			1	11.11	6	18.75	5	7.58				
10 years and more	1	2.94		1	1.92					1	3.13	1	1.52				
Total	34	31.77		52	48.60	12	11.21	9	8.41	32	29.91	66	61.68	6	5.61	3	2.80

*Of 91 patients (85.05 per cent) traced, 58 (63.74 per cent) are living; 33 (36.26 per cent) are dead. Of the patients who were not traced, 16 (14.95 per cent) were living when last heard from.

**Each percentage in any given column is calculated on the basis of the total number of cases in that column. The percentage which corresponds with the total number of cases of a given column is calculated on the basis of 107 cases, or the total number of surgical cases in the series.

thorax and pulmonary metastasis in a third. In a fourth case irradiation was omitted because carcinoma did not appear in sections of the gland until review of the tissue was requested a few months after operation, when metastasis to bone had developed. In a fifth case, post-operative irradiation was given at home. The remaining cases of this group of 10 are too few to be considered separately for determination of purely surgical results. We noted, further, that, in the surgical group, evidence would indicate that all the carcinomas arose on a basis of pre-existent goiter, either of the type of fetal or of colloid adenoma. In none of our cases did carcinoma arise in an exophthalmic goiter. The goiter was of

the thyroid gland are of low-grade malignancy and that, in an appreciable percentage of cases in which operation cannot be performed, irradiation is followed by cure are evidence that these growths are sufficiently radiosensitive fully to warrant post-operative treatment. Because of the frequency with which carcinoma of the thyroid gland develops in a pre-existing nodular goiter, and the difficulty of distinguishing carcinomas in their early stages from benign tumors, surgical removal of all nodular goiters should be considered the treatment of choice, together with post-operative irradiation whenever carcinoma is found.

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DISCUSSION

DR. G. E. PFAHLER (Philadelphia, Pa.): It has been my impression that carcinoma of the thyroid is more sensitive than the average carcinoma. That may, of course, be an impression obtained from relatively few cases; however, it has led me to recommend radiation

therapy in all cases that can be diagnosed clinically as carcinoma.

As Dr. Fricke has said, the diagnosis is very difficult, both clinically and microscopically. Most of the cases I have treated were diagnosed at operation when sections were removed. Cases were found inoperable and we then treated them chiefly by means of roentgen rays. In a few cases, we inserted radium needles in the main tumor mass, which, I believe, is the proper procedure.

One of these cases had been operated upon three times before the patient came to me. Under radium treatment for recurrence, the patient remained symptom-free for about three years, then dying with metastasis to the spine.

In another case, the late Dr. John Deaver told me he removed most of the tumor, but he was quite positive he did not remove all. Although the patient remained symptom-free for 12 years, in the thirteenth year he developed general metastatic carcinoma in the lung. Therefore, we cannot conclude, even if we do arrest the primary disease, that we will not, at some later time, have metastasis to deal with, and we must keep these patients under observation for a long time.

I believe we are justified in recommending the surgical removal of adenomas when the patients consent. If they will not consent, we are justified in recommending radiation treatment.

About two years ago we reported 130 cases of adenoma associated with hyperparathyroidism, which we have treated. None of those cases, up to the present date, has developed carcinoma. That is a relatively small number, but still, in the ordinary percentage value, one or two of those should have developed a carcinoma.

If the roentgen rays will cure carcinoma, I believe we have a right to assume that they will probably prevent carcinoma cells from developing. Therefore, we need not assume that radiation treatment is contra-indicated merely because the patient has an adenoma. Since, however, adenoma is removed with relative ease from the thyroid gland, and this is probably the simplest way out of the trouble,

TABLE IV.—TYPES OF CARCINOMA OF THE THYROID GLAND OF 63 PATIENTS WHO ARE LIVING AND 56 WHO ARE DEAD

Group		Papillary adenocarcinoma			Carcinoma in adenoma		Diffuse adenocarcinoma		Spindle-cell carcinoma resembling sarcoma	
		Cases	Cases	Percentage	Cases	Percentage	Cases	Percentage	Cases	Percentage
Living	Surgical	58	25	43.10*	31	53.45	1	1.72	1	1.72
	Non-surgical	5	2	40.00	2	40.00	1	20.00		
Dead	Surgical	33	3	9.09	25	75.76	5	15.15		
	Non-surgical	23**	7	30.43	5	21.74	7	30.43	4	17.39

*The percentages given in any horizontal line of this table are calculated on the basis of the number of cases given on the same horizontal line, in the column of figures furthest to the left.

**This represents the number of cases, among the non-surgical patients who have died, in which biopsy was obtained. Of the total number of 54 patients who were treated by non-surgical methods, 46 are known to be dead.

and in one a spindle-cell carcinoma resembling a sarcoma (1.72 per cent each). In grades of malignancy, 43.10 per cent of the growths were of Grade 1; 43.10 per cent, of Grade 2; 10.35 per cent, of Grade 3, and only 3.45 per cent, of Grade 4. Among our five living non-surgical patients were two who had papillary adenocarcinomas, two who had carcinomas in adenoma, and one who had a diffuse adenocarcinoma. In three of these cases the neoplasms were of Grade 2, and in two, of Grade 1.

In the surgical group of the 33 patients who died, only three (9.09 per cent) had papillary adenocarcinomas; 25 (75.76 per cent) had carcinomas in adenoma, and five (15.15 per cent) had diffuse adenocarcinomas. By grade of malignancy, 15.15 per cent of the neoplasms were of Grade 1; 54.54 per cent, of Grade 2; 9.09 per cent, of Grade 3, and 21.21 per cent, of Grade 4. Among the 46 patients who are known to be dead in the non-surgical group, biopsy of 23 of the tumors was obtained and the malignancy graded. In round numbers, 30 per cent had papillary adenocarcinomas; 22 per cent, carcinomas in adenoma; 30 per cent, diffuse adenocarcinomas, and 17 per cent, carcinomas resembling sarcoma. By grade of malignancy, 17 per cent of the growths were of Grade 1; 26 per cent, of

Grade 2; 17 per cent, of Grade 3, and 39 per cent, of Grade 4. Again the tendency toward the higher grades of malignancy was well marked in the fatal cases.

CONCLUSIONS

Carcinoma of the thyroid gland is a highly fatal form of malignancy, most difficult to diagnose clinically and histologically. Due to the proximity of the gland to large blood vessels and lymphatic structures, widespread metastasis is common, usually terminating the picture.

Four main types of carcinoma are recognized histologically: (1) papillary adenocarcinoma; (2) adenocarcinoma in adenoma; (3) diffuse adenocarcinoma, and (4) spindle-cell carcinoma resembling sarcoma. The prognosis varies and the types are named in approximately ascending order of malignancy.

Treatment consists of operation only, irradiation only, or a combination of the two. Irradiation only is a poor policy unless the growth is so extensive as to be totally inoperable; then, with irradiation only, palliation usually can be secured, and even cure in the occasional case (10 per cent of our medical series). Surgery only is not justifiable, even if the carcinoma is entirely removed. The facts that most carcinomas of

CASE REPORTS AND NEW DEVICES

HYPERTROPHIC PYLORIC STENOSIS IN THE ADULT

WITH REPORT OF A CASE

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From the Wise, Smith, and Anderson Clinic

Hypertrophic pyloric stenosis in the adult as a cause of gastric obstruction has only recently obtained noticeable clinical recognition. Maier (7) noted the condition at autopsy; Maylard (8) directed attention to the importance of congenital stenosis of the pylorus in adults; more recent writers (2, 4, 10) have called attention to the surgical treatment, and Archer (1) and McClure (9) have lately contributed to knowledge of the roentgen aspects of the condition. The small number of cases described by various authors indicates the relative infrequency with which the condition is recognized.

PATHOLOGY

The essential pathology is a thickening of the musculature forming the pyloric sphincter, with resultant narrowing of the lumen. McClure (9) presents excellent illustrations of the gross and microscopic pathology.

ETIOLOGY

The etiology has not been definitely determined. Among the theories advanced are the following:

1. The persistence, through adult life, of a congenital hypertrophy of the pyloric muscle, insufficient to cause severe obstruction in infancy, but becoming aggravated in later years. Horton's (6) observation of the relative thickness of the pyloric muscle in the fifth and sixth months of fetal life is of interest.

2. Pirie's (11) theory is hyperadrenal-

ism, resultant deficiency in pancreatic secretion, with insufficient neutralization of gastric juices, consequent prolonged pyloric closure, and an eventual occurrence of pyloric hypertrophy and stenosis. Elman and Rowlette (5) suggest that gastric acidity is regulated by the pylorus, rather than that acidity regulates pyloric function.

3. Hypertrophy due to persistent pylorospasm from nervousness or reflex causes (1, 9).

SYMPTOMATOLOGY AND DIAGNOSIS

The presence of a pyloric obstruction is to be suspected in all patients who give a history of epigastric pain relieved by vomiting long retained gastric contents. Among the conditions arising for differential consideration are: large esophageal diverticulum; malignancy or ulcer of the pylorus, with spasm; gastric syphilis or neurosyphilis with gastric crises; pylorospasm, without organic lesion; gastric or duodenal polypi; diverticulosis of the duodenum; duodenal ileus; chronic cholecystitis, with or without stones; pressure obstruction from pancreatic or other extrinsic tumors, and psychic vomiting.

Roentgenologic examination of the gastro-intestinal tract and gall bladder obviously offers the best means of differentiating these various conditions. The chief roentgenologic findings (1) are essentially:

1. A persistent and unchanging increase in the width of the pyloroduodenal interval, "due to an increase in extent of the pyloric ring."

2. The presence, in some cases, of associated spastic incisuræ several centimeters distant from the pylorus.

3. Failure of antispasmodics and fluoroscopic manipulation to alter the pyloric picture.

especially when there is no hyperthyroidism present, it seems to me that removal is a proper procedure to recommend.

When we treat these cases of carcinoma by irradiation, we must remember that we are dealing with carcinoma. It has been my principle, in all treatment of carcinoma, to carry radiation to the limit of the normal tissue tolerance. If we do that, many more of our patients will recover than if we try to give as little radiation as possible. I think often the failure in the treatment of carcinoma is due to too little radiation.

DR. R. H. STEVENS (Detroit, Mich.): I have not had much favorable experience in treating carcinoma of the thyroid. Practically all the cases I have had recommended to me for treatment already had metastasized in the lung, so we have not been able to accomplish very much. There is one case, however, which I would like to mention, a rather rare example, and on which I would like to have Dr. Fricke's opinion. I have not been able to get very much information about it.

A patient, about eighty years of age, developed a pathologic fracture of the clavicle. Upon roentgen examination, the appearance of the clavicle was found to be typical of a metastatic carcinoma. We also found similar lesions in the upper part of the humerus and the upper part of the radius and in the dorsal spine. This patient was apparently in perfect health. We were unable to find any evidence of carcinoma of the prostate or the thyroid. He continued to develop a spastic paralysis of the limbs and finally died from the involvement of the spinal cord.

At postmortem, we searched the thyroid very carefully, sectioning it, and were about to say it was perfectly healthy and normal, when, deep in the thyroid, we came upon a small growth the size of a man's thumb nail, which contained colloidal material. We examined the involved bones and found deposits of the same colloidal material. All of the other organs were perfectly healthy, there were no signs of carcinoma anywhere. There were no carcinoma cells found in the thyroid or bones.

This has been described as "colloidal metastasis." Roentgentherapy was ineffectual.

I would like to ask whether you would classify that under the term "colloidal carcinoma," or what explanation you might have for it.

DR. D. T. QUIGLEY (Omaha, Neb.): Most of the cases of adenomatous thyroid with which I have dealt have been rather young. I would like to ask Dr. Fricke if he considers it probable that these carcinomatous changes will develop in a thyroid adenoma in younger women. Ought we to have the same fear of carcinoma developing in cases in which we see a good many adenomas?

Another type is rather common: the metastasizing tumor of the thyroid which, under the microscope, does not show carcinomatous change. In other words, it is a metastasizing adenoma of the thyroid which is classified by some pathologists as malignant and by others as non-malignant.

Personally I believe any tumor which has metastasized is malignant, but I would like to know Dr. Fricke's viewpoint. Would you, at Rochester, classify that as malignant or has this point been taken into consideration?

DR. FRICKE (closing): Our pathologic data referred to were noted by Dr. Broders and Dr. Bueermann. I wish we had them here to answer the questions.

I think that, in Dr. Stevens' case, metastasis had occurred from a carcinoma in an adenomatous thyroid. As I have mentioned, even pathologists differ on these sections. There are so many histologic pictures simulating carcinoma that the problem is very complex.

Regarding the question of resecting adenomatous goiter from patients about twenty years of age, of course carcinoma may occur in an adenoma at any age, but we are more apprehensive if patients are of the cancer age. The adenomas of persons forty years old or more would be the ones we should be the most anxious to resect.

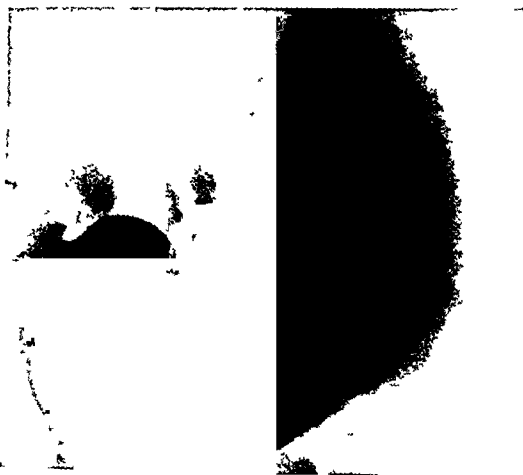


Fig. 1. Note the widened pyloroduodenal interval, hypertrophy of the prepyloric rugæ, and the narrow barium stream through the pylorus



Fig. 2. Eight-hour gastric retention.

sea and epigastric pain occurred during the next four years.

In 1930, about a year prior to roentgen-ray examination, the attacks of epigastric pain and nausea became more severe and frequent. Vomiting usually relieved the pain. These attacks continued for about three months, then they abated in frequency and severity, following treatment of constipation and the use of alkalis. On June 26, 1930, appendectomy was performed for an acute attack but the stomach was not explored. In January, 1931, the attacks of epigastric pain returned with renewed vigor and frequency, occurring as often as twice a week. There was some pain almost every night, but attacks might occur at any time within the 24 hours. About two weeks prior to examination, the writer saw the patient during one of these attacks. Nausea was severe but vomiting difficult. The pain was described as beginning under the left ribs anteriorly and migrating to the epigastrium. There was no palpable tumor, no rigidity, and no particular point of tenderness. The pulse was rapid and the temperature 98° Fahrenheit. Gastric lavage with soda water yielded oranges eaten nine hours previously. No food had been taken after the oranges.



Fig. 3. After gastro-enterostomy. Note that the pyloroduodenal interval remains widened.

The patient was relieved by the lavage. Roentgen examination of the gastro-intestinal tract was made on Feb. 6, 1931.

X-ray Examination.—The esophagus was normal. The stomach showed a wide pyloroduodenal interval, with hypertrophy of the rugæ just proximal to the pylorus, and a nine-hour retention of about 25 per cent of the meal. Hypermotility of the small bowel and a spastic type of colon, with no undue stasis, were noted. The gall bladder was

4. A narrow barium stream through the pylorus.

It is difficult, and at times impossible, to differentiate scirrhus carcinoma of the pylorus and a small ring ulcer with spasm from hypertrophic stenosis (1). The presence of an encircling adhesion about the pylorus may be a source of confusion.

In the advanced cases, the retention of barium beyond a five- or six-hour period (dependent on the type of meal used) will usually occur. The degree will afford a rather good index of the amount of stenosis, as will the extent of narrowing of the barium stream.

An additional roentgen finding, as in the case reported below, may lead to a suspicion of pyloric hypertrophy. Just prior to the sphincter, it was noted that the gastric rugæ were rather plainly marked. It was felt that hypertrophy of the rugæ might also be accompanied by hypertrophy of the musculature of the pylorus. Whether or not this observation is of any value will depend on its being noted in a large number of cases; at present it is merely a suggestion.

Since the nature of the gastric contents may vary so much in disease and in health, gastric analysis offers no dependable diagnostic aid in the presence of this lesion.

Particularly in those cases believed to have their origin in a congenital hypertrophy of the pyloric musculature, the history of attacks of epigastric pain and vomiting over a period of years, reaching back into childhood, is very important and suggestive.

TREATMENT

The treatment is surgical, the majority of writers advising pyloroplasty. Manual dilatation of the sphincter may afford relief, but this is usually only temporary. Gastro-enterostomy, which offers a solution, may be indicated.

The question of dietary following the sur-

gical procedures is best determined by the type of operation employed and the patient's individual needs.

CASE REPORT

It is realized that the interval between the operation and this report (19 months) is rather short, but the nature of the existing pathology and the mechanical effect of the operation lead one to believe that relief will be permanent. The case is suspected of falling in the category of persistent congenital lesions.

A white woman, married, age 24 years, was referred for roentgen examination of the gastro-intestinal tract on Feb. 6, 1931, with a chief complaint of pain in the stomach, and vomiting.

The family and marital history were irrelevant. (Since this initial history-taking, the father has been found to have carcinoma of the prostate, with bone metastases.)

At the age of six weeks, the patient was "poisoned on milk," according to her mother, and suffered with severe attacks of colic and vomiting. These occurred at irregular intervals until the age of 12, when they subsided to some extent.

Childhood diseases included diphtheria and scarlet fever at 4 years, pneumonia at 6, and chicken pox and measles at 12.

The patient's health was better during the period from 12 to 18 years. There were only occasional attacks of indigestion, manifested by abdominal pain and vomiting. She was always thin and had never showed any marked gain in weight. While she was at boarding school, between the ages of 18 and 20, her health was good and there was only one severe attack of abdominal pain, but this was marked by prolonged vomiting. In 1926, at the age of 19, she married. At the time of examination there had been no pregnancies. Occasional attacks of nau-

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USEFUL PROCEDURES IN RADIOLOGIC PRACTICE

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Abstract.—Many diagnostic and therapeutic radiologic procedures, unquestionably definite improvements over the current routine technic, are not reported on account of their apparent elementary simplicity. We offer a few suggestions which may prove of service and stimulate others to contribute helpful suggestions.

(1) In lieu of the customary sheet lead, employed in shielding one-half of the film holder during a roentgenographic exposure, one may place sheet lead (7 in. \times 17 in.), of identical thickness ($3/32$ in.), between two pieces of relatively thin veneered wood, fastened together, preferably with short rivets. The arrangement possesses the following advantages: (a) A straight edge which gives the completed film a clean-cut appearance; (b) a shielding for the patient, when one is employing the four-port technic of deep roentgentherapy (since the lead is insulated by the apposing wooden surfaces, troublesome static discharge is entirely eliminated); (c) neatness of appearance.

(2) Occasionally a complete set of dental films is discarded because they are lacking in density and contrast, or the reverse. To obviate this, the duplicate dental films are separately mounted upon two

dental film hangers, one set being developed one minute longer and the other set one minute less than the standard developing time. Obviously, one set of films will be slightly lighter and the other slightly darker than if the standard developing time had been used. One of the sets is almost certain to meet with approval.

(3) In using radiographic cones, cylinders, and diaphragms, the radiographer does not always take into consideration that it is not merely the diameter of the cone that increases the quality of the roentgenogram, but, rather, the size of the port of entry of the primary beam. A dental cone will present its maximum effect only when it is positioned as close to the object as is feasible. The more relatively distant the skin-target distance, the larger will be the exposed area, and consequently the larger will be the port of entry. If the distance from the target to the film is such that the size of the port of entry is 5 in. in diameter, the small dental cone will be of no more value from the standpoint of increasing the contrast of the film than would be a larger cone with a diameter at the open end of 5 in. in direct contact with the part. A flexible rule for the operator in the employment of radiographic cones is as follows: The smaller the exposed area, equivalent to the port of entry, the greater is the resulting contrast, provided this restriction is effected by the cone. However, when employing cones at variable distances, particularly when exceeding 25-in. film-target distance, it is often problematical whether or not the primary beam is effectively utilized, and, also, whether the film is being properly covered by the x-radiation. This uncertainty is experienced particularly when the filter is one or two millimeters of aluminum, the endeavor being to minimize the possibility of radiodermatitis as a result of excessive exposure, by filtering out the deleterious and undesirable soft x-radiation. Furthermore, it is deemed advisable never to make ex-

seen to be normal by oral cholecystography. There was no evidence of pulmonary pathology.

It was thought that the gastric retention was functional and due to a pylorospasm. The former appendectomy and the normal appearance of the gall bladder on the cholecystogram practically eliminated these two organs as sources of reflex spasm.

Gastric Analysis.—Feb. 9, 1931. Total acidity 47; free hydrochloric acid 39.5.

Blood Wassermann and Kahn tests were negative, as was the urinalysis. Basal metabolic rate, —12.

The patient was placed on medical treatment, including belladonna in ascending doses, and a smooth and liquid diet. During the following two months, the constipation was somewhat relieved, but the attacks of epigastric pain persisted, although less in severity and frequency. Substitution of full liquid diet for the low-residue diet failed to prevent the attacks.

At the end of the two months, roentgen examination was repeated. The findings were essentially the same, with about 20 per cent gastric retention at eight hours. The appearance of the pylorus was unaltered. Atropine (1/75 gr. hypodermically) failed to affect the pyloric findings or to decrease materially the gastric retention. In view of the absence of a demonstrable ulcer, the appearance of the pylorus, the gastric retention, and the long history of colic and vomiting, pyloric muscle hypertrophy was suspected and exploration advised. The second consideration was encircling pyloric adhesions.

On April 24, 1931, operation disclosed marked thickening of the pyloric muscle, with narrowing of the lumen. There was no evidence of ulcer or neoplasm. There were a few adhesions about the second portion of the duodenum, judged insufficient to cause obstruction. Posterior gastro-enterostomy was performed and recovery was uneventful.

In August, 1931, there was some pain

over the left abdomen, with nausea and vomiting, gaseous distention, and tenderness over the descending colon. This was relieved by medical treatment. There have been no further attacks of nausea, vomiting, or epigastric pain. The general health is good.

Roentgen examination on Jan. 12, 1932, disclosed a normally functioning gastro-enterostomy, with the stomach empty in about three-and-a-half-hours, but the appearance of the pylorus remained unchanged.

In November, 1932, the patient gave birth to a child, successfully going through a low forceps delivery. The infant weighed 9.5 pounds.

SUMMARY

1. Attention is called to the clinical significance of hypertrophic stenosis of the pylorus in adults.
2. The pathology, etiology, symptomatology, diagnosis, and treatment are briefly reviewed, with special reference to the roentgen findings.
3. A case is reported showing the clinical features, roentgen findings, and surgical pathology of hypertrophic stenosis of the pylorus, with operative relief of symptoms.

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from the outer aspect of the hip to be examined. This is comparable to the Costes' position.

(8) In suspected fracture of the nasal bone, a lateral view of the region is made by placing a regular or large size dental film in direct apposition to the outer side of the nasal bone region, and focusing the dental cone in a directly transverse line from the opposite side. This eliminates the undesirable magnified distortion present in the routine lateral projections of this region, due to the great distance of the film from the nasal bone.

(9) There are sundry uses for dental films other than in roentgenography of the teeth, such as their application in taking lateral views of the phalanges. The dental packet is deftly inserted between the phalanx to be examined and the adjacent one, focusing the x-ray tube upon the outer side of the former. Anteroposterior views of these digits are also made upon dental films. Special limiting views of the carpal bones upon dental films, in suspected pathologic conditions, are excellent for demonstrating minute detail. In this respect, however, a word of warning will not go amiss: never radiograph any small confined area without initially taking a larger view of the region in question, in order to make certain whether or not other fractures or, possibly, pathologic conditions, exist, of which the patient does not complain. These unsuspected conditions may be completely overlooked if they are not included in the larger field of examination.

(10) The use of the shock-proof dental unit in conjunction with the Altschul technic offers an ingenious method of radiographing the temporo-mandibular articulation. In this examination, the patient lies in the true lateral decubitus, with the temporo-mandibular joint positioned in the center of an 8×10 cassette. The dental cone is positioned close over the base of the coronoid process of the opposite side, which enables

one to haze out, as it were, the detail of the normal side by the phenomenon of magnified distortion. The central beam is then directed toward the temporo-mandibular articulation under observation, tilting the cone 25° caudocranially and 20° fronto-occipitally.

(11) An unusual longitudinal view of the patella is procured by flexing the affected knee as acutely as possible, with the patient himself holding an 8×10 cassette in position upon the anterior surface of the distal end of the femur just beyond the inferior border of the patella. The central ray of the shock-proof or other unit is projected cephalad and dorsad, toward the central portion of the film. It is to be noted that the less the degree of flexion obtained, the greater the film-target distance. This projection presents an admirable view of the anterior and posterior surfaces of the patella, in a longitudinal perspective, not demonstrable by any other method.

(12) Mastoid tip projections are more readily taken by the dental unit than by the routine technic. While the patient sits in the dental chair the cone can be positioned dexterously.

(13) It undoubtedly has been the experience of all who employ the oral method of cholecystography that occasionally, in the administration of the dye, the patient experiences an untoward reaction, manifesting itself in a pronounced diarrhea. This, of course, renders the test valueless, inasmuch as the dye is insufficiently absorbed, during its hurried passage through the alimentary tract, to visualize a normally functioning gall bladder. Not only is this an undesirable reaction from the patient's standpoint, but if he is inadvertently not questioned and does not volunteer information, the diarrhea may be unknown and an entirely misleading diagnosis of non-functioning gall bladder may be made, and unwarranted operative procedure may be instituted. This idiosyncrasy to the gall-bladder dye can be

posures of the head without the insertion of at least 1 mm. of aluminum as a filter. That this procedure is extremely important from a medico-legal standpoint is incontrovertible; but the inherent disadvantages of cutting off the localizing cone of light when the aluminum filter is in position often tempt the operator to omit the filter, thereby entailing the risk of omitting it in routine roentgenography. It must be conceded that one is unable to differentiate a film taken with 1 mm. Al from one taken without a filter.

(4) Since a single thickness of ordinary sheet window glass has the same approximate absorption coefficient and relatively equivalent filtration value as 1 mm. of aluminum, it is patent that this can profitably be employed in lieu of the aluminum filter, permitting of filament illumination for focusing and localizing purposes. If the equivalent filtration value of 2 mm. of aluminum is desired, two thicknesses of ordinary window glass are employed. An added convenience which enables one to obtain the exact center of the primary beam is a small round piece of black paper pasted in the exact center of the glass filter. This procedure outlines the field of radiation with a central unilluminated area which corresponds, for practical purposes, to the center of the primary beam, which can then accordingly be directed to the desired position. This procedure is helped considerably by slightly darkening the radiographic room. The glass filter should be of sufficiently small size to permit of a slight amount of play when in position. It is desirable to further reinforce all sides of the filter with thin strips of adhesive plaster along the edges, a safeguard which will aid in preventing the inopportune breaking of the glass filter.

(5) It is true that the average technician uses a cone of much larger diameter than is necessary to cover the desired area, thus defeating the very purpose of the cone. By utilizing the beam of light, this error

is corrected by merely viewing the actual area covered by the cone and then substituting a cone of proper size. In stereoradiography, the cone of light is a useful adjunct in the determination of the proper tilt of the cone. Again, this is also desirable in radiography of the chest, the infrequently used and neglected cone being an important factor in increasing the contrast of the film.

(6) Many difficult angles and unusual views in roentgenography often can be obtained only by the judicious use of a shock-proof dental unit, either oil-immersed or of another type of insulation. The extremely fine focus of a dental x-ray tube lends itself admirably to the obtaining of the maximum in minute detail such as is wellnigh mandatory for the proper interpretation of pathologic bony structure. An extraordinary view of the head of the humerus, acromion process, and outer end of the clavicle is obtained by focusing the dental cone directly cephalad in the axillary pit, with the cassette resting upon the shoulder, supported by the patient's other arm. Frequently, fractures not to be detected in the ordinary projections, especially in the region of the anatomical neck of the humerus, were readily disclosed by this method.

(7) True lateral projections of fractures about the head and neck of the femur are obtained with the aid of a shock-proof dental unit. This is accomplished by placing the patient in Arcelin's position, *i.e.*, the dorsal decubitus with the thigh flexed 90° upon the normal hip. The film is then placed on the outer border of the hip to be examined, and held securely in position, either by the patient or a sand bag. The dental cone is focused laterad and slightly cephalad on the medial aspect of the affected hip, and the exposure made.

Another excellent lateral view of the hip is procured by reversing the above procedure. The cassette is pushed cephalad, between the thighs, into the perineum, with the dental cone focused caudad and mesiad,

white, with large black figures, "1" meaning "1 mm. of aluminum," *et cetera*. The tabs are marked on both sides so that, irrespective of which side of the filter is inserted in position, the number designating the filtration faces the observer. An identical procedure is followed for the copper filters with the exception that the tabs are painted red, with large white figures, such as " $\frac{1}{2}$ " for 0.5 mm. of copper, " $\frac{1}{4}$ " for 0.25 mm. of copper, *et cetera*. The tabs are fastened upon the filters in such a manner that, when two or more filters are employed concurrently, they are so spaced as to permit all the numbers being read. The total combined filtration value can be readily determined. For example: red tabs marked " $\frac{1}{2}$ " and " $\frac{1}{4}$ " and white tabs marked "1" and "2." indicate a total of .75 mm. of copper plus 3 mm. of aluminum filtration.

(17) Much annoyance can be avoided if the outlines of areas of irradiation are initially painted on the skin with a semi-permanent stain of the following composition: Equal parts of an aqueous sol. of gentian violet and a 50 per cent sol. of silver nitrate mixed together. The gentian violet readily stains the skin at the first application, to properly delimit the fields. As the treatment progresses, the gentian violet stain becomes fainter and eventually completely wears off. However, the silver nitrate stain has penetrated the epidermis and is discolored, due to the action of the light upon it, and thus the areas are well defined even after the lapse of considerable time. This procedure has been found far more valuable and effective than any other single stain, including mercurochrome and methyl violet.

(18) Probably the most nervous and apprehensive patients are those cases of hyperthyroidism undergoing x-radiation of the thyroid gland. This excitability is especially marked and aggravated when the face is covered with the protective leaded rubber sheet, and particularly so at the first séance.

Unquestionably, much of the unwarranted fear could be allayed if the patient were permitted to observe the proceedings. This is effected by placing an ordinary protective face mask equipped with leaded glass lenses, such as is commonly employed by the roentgenologist in fluoroscopy, upon the face of the patient, and adjusting the leaded rubber extending below the chin to suit.

(19) The roentgentherapy of many benign and malignant skin lesions, especially basal-cell carcinomas about the face, can be greatly facilitated by the following device, designated to make two pieces of protective material serve for an unlimited number of treatments. The ordinary protective sheet lead or leaded rubber is cut to conform to a 10×15 cm. size. Then, upon this rectangle, two rows of apertures of increasing diameter are made, spaced 1.5 cm. apart for the smaller openings and 2.5 cm. for the larger apertures. Their shapes will be noted later. In a separate piece of sheet lead or leaded rubber, 15×15 cm., a centrally placed circular opening is cut, in diameter slightly larger than the greatest diameter of the largest graded opening in the first piece and yet sufficiently small to permit the second piece to cover the adjacent openings when the second piece is placed over the first. In practice, the aperture of a size to sufficiently expose the lesion, inclusive of a slight margin of surrounding healthy tissue, is chosen by fitting the graded openings over the lesion until the opening of proper size is determined. Then the aperture in the second piece of sheet lead or leaded rubber is placed over this opening, completely protecting the adjacent skin from x-radiation by covering the undesired openings. In the first piece, various shapes and sizes of openings, such as elliptical, comma-shaped, etc., are profitably made for the treatment of irregularly shaped areas. By properly combining the above shapes and sizes, lesions of any description can be successfully dealt with. In addition,

entirely eliminated by the simultaneous ingestion of from one to four fluid drachms of *tincturæ opii camphoratae*, with the repeated cholecystographic medium.

(14) The fact that motion, both physiological and involuntary, and accidental or voluntary, plays such an important rôle in the final quality of a film, emphasizes the increasing necessity for higher capacity equipment and added technical skill. One may acquire ability to judge accurately how long the patient or part can remain or be maintained motionless; to so change the physical factors involved as to secure radiographs of the highest quality in the allowable exposure time and to effectively immobilize the part. The inherent difficulty of eliminating the involuntary motion caused by respiration is unquestionably the most persistent cause of improper visualization in cholelithiasis. The customary instructions cursorily given the patient—to take a deep breath and hold it—are too frequently misunderstood, the patient slowly exhaling during the exposure, and causing slight motion of the diaphragm and viscera, with consequent blurring and indistinct visualization of the gallstones or gall bladder. When dealing with patients who do not understand the language spoken, one should employ the following technic. A temporary state of apnea is created in the patient, immediately before the exposure is to be made, by telling him to take a dozen or more deep breaths, after which a nose-pincher device, such as is commonly employed in basal metabolic rate estimations, is used as an added precaution. He is then told to keep the lips tightly closed, whereupon the exposure is made. This procedure eliminates all breathing, conscious or unconscious. It is wellnigh impossible for an apprehensive or unintelligent person to hold his breath upon merely being told to do so, without supplementary precautions having been taken.

This same procedure is practised in serial-

ography of the stomach, with the patient pinching his own nose with his hand, in lieu of the mechanical contrivance. This procedure, when once routinely established, is well worth the added time necessary for its proper performance.

(15) There are many conveniences and various time-saving devices in the realm of radiotherapy, such as the routine use of a synergistic combination of a mild hypnotic and a sedative. This is an invaluable prophylactic procedure in allaying much of the nausea and vomiting, lassitude and depression, familiarly encountered in radiotherapy, and especially marked in deep roentgen-therapy. A capsule consisting of one grain of phenobarbital and ten grains of sodium bromide, administered one hour before irradiating the patient, is quite effective. Post-irradiation therapy consists of further neutralization of the untoward effects by the expeditious use of four drachms of glucose and one drachm of an alkali, either sodium bicarbonate or, preferably, calcium gluconate, in a glassful of orange juice as an excipient. It is to be stressed that the beneficial effects depend upon the immediate ingestion of the mixture after irradiation, not allowing the patient to procrastinate until the untoward effects make their appearance; after they do, this procedure is much less efficacious.

(16) The unpardonable sin in roentgen-therapy is the neglectful omission of a filter. It is an excellent rule to train the assisting technician always to recheck the amount of filtration, prior to irradiating the patient. After the completion of a treatment, always replace the maximum amount of filtration in position. Further precaution which may be taken to prevent omission of a filter is to so modify the filters that they are readily visible from the control room. This may be done by riveting or soldering an aluminum or copper tab to the respective filters, the tab to be freely movable, i.e., hinged. The tab on the aluminum filter is painted

EDITORIAL

LEON J. MENVILLE, M.D. . . . *Editor*
BUNBY ALLEN, M.D. . . . *Associate Editor*

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By neglecting to use radium in its appropriate fields, one often does not simply turn to surgery as a suitable and equally effective alternative, but does actually condemn patients to unnecessary suffering, invalidism, and even to death, who might have been saved by the more effective remedy.

HOWARD A. KELLY, A.B., M.D.,
F.A.C.S., LL.D.

THE AMERICAN CONGRESS OF RADIOLOGY

EDITORIAL BY THE PRESIDENT OF THE
CONGRESS

The first American Congress of Radiology will be held at Chicago, September 25 to 30, 1933, at a time when the Century of Progress Exposition shall be at its best. There seems to be some lack of complete understanding on the part of a few members of the Radiological Society of North America and other societies directly interested as to the real purpose of this Congress. It will be an entirely new venture for American radiologists, but with every promise of complete success, and a few words by way of explanation seem fitting for the benefit of those who do not yet realize the real aims and objects.

The idea had its inception in the minds of a few radiologists soon after the first announcements were made that a Century of Progress Exposition was to be held in Chicago in 1933. These men believed that the

interests of radiology as a medical specialty could be advanced by holding a combined meeting of all of our American radiological bodies as a unit in conjunction with the Exposition. The four national societies, namely, the Radiological Society of North America, the American Roentgen Ray Society, the American College of Radiology, and the American Radium Society, appointed representatives to formulate plans for such a Congress. These four societies are, therefore, the sponsors for the Congress, and all radiological societies of North and South America will receive invitations for their members to attend.

The organization of the Congress is vested in an Executive Council composed of Benjamin H. Orndoff, M.D., *Chairman*; Edward L. Jenkinson, M.D., *Secretary*; Henry Schmitz, M.D., *Treasurer*; James T. Case, M.D., Maximilian J. Hubeny, M.D., Byron H. Jackson, M.D., B. R. Kirklin, M.D., Leon J. Menville, M.D., Lawrence Reynolds, M.D., John T. Murphy, M.D., George E. Pfahler, M.D., and Albert Soiland, M.D. The Council elected Henry K. Pancoast, M.D., as President of the Congress and appointed as Vice-presidents the four Presidents of the sponsoring societies—Byron H. Jackson, M.D., John T. Murphy, M.D., Albert Soiland, M.D., and Rollin H. Stevens, M.D. These men will preside at appropriate sessions.

Only members of the Council will act as chairmen of the ten standing committees. Every effort has been made to ensure fair representation. For example, the editors of the two journals will serve as co-chairmen of the Committee on Publication, and Dr. Pfahler, Chairman of the Committee on Scientific Program, will have as his co-workers the secretaries of the purely scien-

these shields may be valuable in the localization of the lesion, when employing Doane's bipolar method of electrocoagulation. This method can be used either prior to, or without, coincident x-radiation. The shield acts as the indifferent electrode, and the active electrode, the coagulating needle, is placed within this area; after electro-

coagulating the lesion, further x-radiation may be instituted without disturbing the lead shield over the area being treated.

In conclusion, it is our purpose in this presentation of radiologic "shop notes," to advance radiological technic. We do not wish to assume credit for the originality of all of the procedures herein offered.



The late JOHN F. HERRICK, M.D.

J. F. HERRICK, M.D., SUMMONED BY DEATH

Dr. J. F. Herrick, 69 years old, prominent radiologist, died after a long illness (lymphatic leukemia) on February 23, at St. Joseph's Hospital, Ottumwa, Iowa.

We all remember John Herrick as a pioneer radiologist, and one of the first to help organize the Western Roentgen Society, now known as the Radiological Society of North America. His interest in this Society was strong and continuous: he was ever ready to help in its progress and advancement. When the occasion demanded it he did not mince words in expressing approval or disapproval when he thought such a course was for the Society's good. He held

various offices of trust in the Radiological Society in the most efficient, courageous, and impartial manner.

His many contributions to the science of radiology are too numerous to mention, but suffice it to say that the radiological profession of this country looked upon the contributions of John Herrick as being representative of the modern progress of radiology—illuminating, interesting, and educational.

John Herrick's activities were numerous. Besides enjoying a large, lucrative practice in radiology, he found time to engage in many civic enterprises, being looked upon by the people of his town as a leader upon whom they could depend. He was a devout man. He was close to his church. On February 4, when at High Mass in the chapel of St. Joseph's Hospital, where he died, he received a special blessing, communicated over the new direct system which has been set up from the Vatican City for the American continent.

He held a splendid war record, serving overseas for a long period as Major connected with Base Hospital No. 32 of Indianapolis, Indiana.

The members of organized radiology will miss their friend and co-worker John Herrick. The annual meetings of this Society will never be the same with him absent. He will be missed by all, particularly by the younger members of the profession whom he was always ready to encourage and help. We shall treasure his memory as one of our most precious recollections.

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tific societies and the president or president-elect of each of the societies whose duty it would be to work out the program for his respective society. The chairman of this important committee is ready to request volunteers on the scientific program.

The scientific sessions of the Congress will be held in the Palmer House, Chicago, September 25 to 30, 1933. The scientific and commercial exhibits will be conveniently located in the same hotel.

It is planned to hold only morning sessions with two sections, one on diagnosis and one on therapy, except that on the first morning there will be but one combined session. Probably two evenings will be devoted to the Convocation of the Radiological Society and awards, conducted by the officers of the Society, the Janeway Lecture under the auspices of the American Radium Society, the Caldwell Lecture under the patronage of the American Roentgen Ray Society, and the Convocation of the American College of Radiology. Two of these events will be held on each of the two evenings. In this way ample opportunity will be provided for all members and guests to visit the Exposition during the afternoons and the remaining evenings. These will indeed be opportunities of a lifetime.

The permanent headquarters and business office of the Executive Council and Administration are at 2561 North Clark Street, Chicago, to which any inquiries may be directed.

This Congress is designated as a meeting wholly in the interests of radiology as a specialty in medicine, in its relations with other branches of this profession and the science of physics, as a means of collective research, and as an exceptional opportunity to create in the public mind a proper attitude towards a specialty which has for its object the benefit of humanity. It is sponsored by four great Societies, each of which has had and will continue to have a worthy purpose in its existence, but has realized the

wisdom of working together for a common interest.

HENRY K. PANCOAST, M.D.
President of Congress.

AMERICAN CONGRESS OF RADIOLOGY

COMMITTEE ON SCIENTIFIC PROGRAM

On January 28, 1933, a meeting of the Scientific Program Committee was held in Philadelphia at which the following were present:

Henry K. Pancoast, M.D., Eugene Pendergrass, M.D., John T. Murphy, M.D., Byron H. Jackson, M.D., Leopold Jaches, M.D., William A. Evans, M.D., and George E. Pfahler, M.D.

It was decided that we should hold two evening sessions.

It was decided to hold no banquet and no dance. This was done for the sake of economy of time, money, and energy.

The first evening session shall be on Wednesday, Sept. 27, at 8:30 P.M. sharp, at which time there will be a convocation of the American College of Radiology, and a brief address by the President. It will be conducted by the officers of the American College of Radiology, who will, in turn, introduce the officers of the American Roentgen Ray Society, who will officiate at the Caldwell Lecture.

On Friday, Sept. 29, at 8:30 P.M., there will be a convocation of the Radiological Society of North America, and an award of medals and honors, conducted by the officers of the Radiological Society of North America, who will, in turn, introduce the officers of the American Radium Society for the special purpose of conducting the Janeway Lecture by Professor James Ewing.

It was decided to request Dr. Orndoff, Chairman of the Executive Council, to introduce the speakers at the opening session of the Congress, until Dr. Pancoast, the

President of the organization, has been introduced, after which he will conduct the proceedings.

It was decided to divide the scientific sessions into three approximately equal divisions, and request the officers of the American Roentgen Ray Society, the Radiological Society of North America, and the American Radium Society to conduct the scientific sessions. At the evening sessions, Dr. Pancoast shall introduce the President and officers of the Societies who open the meeting.

It was decided to omit all discussion. This will permit some additional papers, and, we believe, permit us to run the meeting more definitely on schedule. This will of necessity eliminate the names of men who previously have been listed for discussion, and who for the most part are not members of the radiological societies, and will permit those who are members, and who were scheduled for discussions, to prepare papers.

It was decided to request many of the speakers to abstract their papers to five or ten minutes, and some of them to permit their papers to be read by title.

It was ordered that every author must submit his paper to the Secretary at the time of presentation so that it can properly be published in one of the two Journals, and, in order that this be understood, a notice to this effect shall be sent from the Executive Secretary's office after the program is completed to each author or participant. This will permit us to omit the cost of stenographers. A stenographer will be needed only for the executive sessions of the various Societies, which executive sessions will be arranged for, and the expense thereof borne directly by the Societies.

It is requested that the Editors of the two Journals give some notice to this meeting in every issue of the journals until the time of the Congress. In the next issue of these Journals, it is hoped that the request for volunteers for the program will be published. For the subsequent issue, it is requested that

Dr. Pancoast, President of the Congress, write a brief statement of the aim and reasons for the Congress. In the succeeding issue, it is likely that we will be able to publish the preliminary program.

The entire program was then reviewed to date, and rearranged on the basis of omitting discussions, and some additional men named, who are to be specially invited.

G. E. PFAHLER, M.D., *Chairman.*

ANNOUNCEMENTS

CLEVELAND RADIOLOGICAL SOCIETY

R. J. May, M.D., is President of the Cleveland Radiological Society and M. A. Thomas, M.D., is Secretary-Treasurer. The meetings are held on the fourth Monday of each month at the Cleveland Chamber of Commerce at 6:30 P.M., from October to April, inclusive.

FLORIDA RADIOLOGICAL SOCIETY

W. McL. Shaw, M.D., of Jacksonville, Florida, Secretary-Treasurer of the Florida Radiological Society, wishes the publication of notice to the effect that the next meeting of that Society will be held in Hollywood, Florida, on May 1.

MINNESOTA RADIOLOGICAL SOCIETY

The Winter Meeting of the Minnesota Radiological Society was held at the Nicollet Hotel, in Minneapolis, on Saturday, February 18, 1933, at 2:00 P. M. The following program was presented:

1. Pre-operative Diagnosis of Malignancy of the Liver with Thorotrast.

LESTER G. ERICKSEN, M.D., Minneapolis.

2. The Physical Basis of Chest Radiography (Work of R. G. Wilsey) and the Ruggles Cine-cardiographic Film. ROBERT G. MORRISON, Minneapolis.
3. A Simplified Technic for Roentgenography of the Optic Canals. JOHN D. CAMP, M.D., and CESARE GIANTURCO, M.D., Rochester.
4. Atypical Findings in Bone Lesions. CHARLES G. SUTHERLAND, M.D., Rochester.
5. Roentgenologic Study of Bone Changes Accompanying Neurofibroma of the Spinal Cord and Associated Nerves. JOHN D. CAMP, M.D., Rochester. Discussion by W. A. O'BRIEN, M.D., Minneapolis.
6. Case Reports from the University Hospital:
 - (A) Demonstration of Methylene Blue Method for Calibrating Roentgen-ray Dosage. W. K. STENSTROM, PH.D.
 - (B) Achondroplasia, Advanced Ossification, Vertebral Osteochondritis. JOHN B. ENEBOE, M.D.
 - (C) Carcinoma of Breast, Skeletal Metastases, Response to Radiation. C. O. HANSEN, M.D.
 - (D) Carcinoma of the Skin: Response to Radiation. FREDERICK B. EXNER, M.D.
 - (E) Simulants of Mediastinal Masses. LEO G. RIGLER, M.D.

The Society was honored by the presence of Dean RICHARD E. SCAMMON, PH.D., of the University of Minnesota Medical School, who delivered an illuminating and stimulating address on "The Contributions of Radiology to the Study of Growth."

At the business meeting a resolution was adopted endorsing the principles of the Code of Ethics of the Philadelphia Roentgen Ray Society.

The next meeting of the Society will be held in Rochester, Minn., May 22, 1933.

SUPPLEMENTAL LIST OF PARTICIPANTS IN THE SCIENTIFIC EXHIBIT AT THE ANNUAL MEETING¹

F. F. BORZELL, M.D., Frankford Hospital, Philadelphia, "Erythroblastic Anemia Contrasted with Sickle-cell Anemia and Severe Secondary Anemia."

ROBERT B. TART, M.D., Charleston, S. C., "Ancient Egyptian Mummy: A Radiographic Study."

MAURICE LENZ, M.D., Presbyterian and Montefiore Hospitals, New York City, "Difficulties in Radiotherapy of Epithelioma of Head and Neck."

CARLETON B. PEIRCE, M.D., University of Michigan, Ann Arbor, "The Superior Mediastinal Spaces."

HAYES E. MARTIN, M.D., Memorial Hospital, New York City, "Cancer of the Lip, Tongue, and Cheek."

A. W. ERSKINE, M.D., and C. L. GILLIES, M.D., 326 Higley Building, Cedar Rapids, Iowa, "Injuries of the Wrist."

HENRY K. TAYLOR, M.D., Sea View Hospital, New York City, "Pulmonary Tuberculosis: A New Clinical Classification."

W. G. HERRMAN, M.D., Monmouth Memorial Hospital, Long Branch; Fitkin Memorial Hospital, Asbury Park, N. J., "Fusospirochetal Infection of the Lung."

ALFRED F. HOCKER, M.D., Memorial Hospital, New York City, "Roentgen Visualization of the Parotid Gland."

B. R. KIRKLIN, M.D., Mayo Foundation for Medical Education and Research, Rochester, Minn., "Papilloma of the Gall Bladder."

VOLUME XX TO BE INDEXED

To give our readers the most service possible, pending the completion of the monumental Subject Index covering the publica-

¹These additional names were received by the Editor after publication of the January issue. They are to be considered as supplementing the exhibitors as named on page 46

tions of the Society since 1918, the Editor announces that a Subject Index of the present volume is in preparation, to be included in the June issue.

EDITORIAL STAFF

The omission of the names of members of the Editorial Staff from recent issues does not mean that RADIOLOGY does not look to them for advice and co-operation as in the past; the omission has been decided upon by joint deliberation of the Executive and Publication committees, solely as a measure to make more space available for the publication of papers. Owing to the reduced size of RADIOLOGY, all members of the Editorial Staff in attendance acceded to the omission with the above-named object in view. It is the hope presently to resume the printing in each issue of the names of the Staff, but for the present, they have agreed to this economy.

portion, he submits proof of the existence of and of the pathologic importance of a cancerous and cancerizable *milieu*. In the second portion, there is a detailed discussion of the physiology and metabolism of cancer tissue. In the third part, there are some practical considerations, and in the fourth portion there is a complete description of the apparatus and the technic employed in the study. The author has carried out extensive studies on the hydrogen-ion concentration both from a physiochemical and a clinical point of view and feels, as a result of his experience, that these studies are of both a diagnostic and a prognostic significance. In this connection it is interesting to mention that in those cases in which roentgentherapy is to be beneficial the pH drops toward the acid values.

Such a study as the author's on hydrogen-ion concentration, supplemented by determinations of calcium-potassium balance, may open an interesting phase of the study of the inheritability of cancer; and, even though it is too soon to make positive statements or draw definite conclusions about the value of the author's book, it nevertheless deserves serious consideration by all who have an interest in the biology of cancer.

BOOK REVIEWS

LE TERRAIN CANCÉREUX ET CANCÉRISABLE.

By RENÉ REDING, Directeur de la Fondation Yvonne Boël Adjoint à la Clinique Chirurgicale Universitaire de l'Hôpital Saint-Jean. From Fondation Yvonne Boël (Hôpital Brugman) and Laboratoire de Cancérologie de l'Hôpital d'Ougrée-Marihay. Paris, Masson et Cie., 1932. Paper, pp. 389, 17 figures. Price 50 francs.

The study of the biologic phases of cancer and carcinogenesis is growing steadily in importance, especially since the trend of thought has been that cancer cells grow better in an alkaline medium and that their growth is retarded or prevented when the medium is acid. In this book, Reding summarizes some extensive research work done by himself and his late chief, Professor A. Slosse. In the first

PRÉCIS DE CANCÉROLOGIE. By J. DUCUING, Professor Faculty of Medicine, Surgeon-in-chief of the Hospitals and Director of the Cancer Center of Toulouse, France. A cloth-bound volume of 1,259 pages, with 516 illustrations. Published by Masson et Cie., Paris, 1932. Price, 140 francs.

Intended as a brief summary of the entire subject of cancer from every point of view, this volume cannot be expected to deal exhaustively with any one phase of the subject. It deals succinctly but adequately with malignant tumors from the standpoint of classification, etiology, symptomology, diagnosis, pathogenesis, histology, and treatment of all the different kinds of carcinoma, sarcoma, and other varieties of tumor. The object of the book is to familiarize the medical student and general practitioner with the latest ideas on these dif-

ferent aspects of the complicated question of malignancy. The numerous illustrations include photographs showing the external appearance of many lesions, as well as photomicrographic drawings and diagrams illustrating the lymphatic drainage as applied to different kinds of tumors. Unretouched photomicrographs were not included because, as the author rightfully states, the student is unable to obtain much information from them. Therefore, the histologic illustrations are drawings carefully made from photomicrographs to bring out the essential features and to leave out all confusing detail. In dealing with the treatment of malignant tumors all the recognized forms of treatment, including surgery, roentgen rays, and radium, are mentioned and their relative merits analyzed.

In general, it may be said that the discussion of the different subjects is sane and sound. Objection might be taken to some statements if the work were more pretentious or more exhaustive, but in a book the object of which is chiefly to furnish as much information as possible in a small compass the author might be forgiven for not having mentioned certain points.

In connection with treatment the author has been at pains to discuss radiotherapy, and this part of the book is, on the whole, quite satisfactory. The methods and technic advocated are based chiefly on those used by well known French workers such as Regaud, Laborde, Ferroux and others. Although a summarized work of this kind cannot be expected to include a discussion of many details which one would expect in a more complete treatise, nevertheless it is surprising that the author has not even mentioned the value of radiography as a diagnostic procedure and as a means of identifying and classifying certain varieties of tumor. In the discussion of the various theories which have been advanced to explain the etiology of cancer, nothing has been said about the mutation theory. Also, the value of a biopsy and of microscopic examination of tissues excised for the purpose is slightly exaggerated by making it appear that the results of such examination are necessarily conclusive. Another subject which has

been omitted is the diffuse endothelioma of Ewing, or endothelial myeloma of Kolodny, in connection with malignant tumors of bone. In spite of these few lapses, however, the book has achieved its primary purpose and should be of distinct usefulness to students and physicians who wish to familiarize themselves with the present status of the cancer question.

PNEUMOLYSE INTRAPLEURALE (*Intrapleural Pneumolysis*). By LOUIS SAYÉ, Professeur à la Faculté de médecine de Barcelone, Directeur du Service de l'Assistance sociale aux tuberculeux, Membre de l'Académie de médecine. Preface by Professeur LÉON BERNARD. A volume of 238 pages, with 119 figures. Published by Masson et Cie., Paris, 1932. Price, 40 francs.

Under the editorship of L. Bernard (University of Paris) a series of monographs are published, called "Bibliothèque de Phthisiologie." Although they are apparently written primarily for the physician specializing in tuberculosis, some will undoubtedly interest a wider circle of medical readers. The volume contributed by L. Sayé, Professor of Medicine at the University of Barcelona, deals with a phase of pulmonary tuberculosis therapy which has made remarkable progress during the last ten years. The technic, results, and possibilities of the cutting of adhesions within the chest by means of high frequency currents are ably discussed by the author. The work of Jacobæus and certain American authors as, for instance, Matson, is given full credit. The roentgenologist will be pleased to find numerous reproductions of roentgenograms in the text, showing the chest before and at certain intervals after the operation. Particularly instructive are the schematic drawings of the thorascopic picture which can thus be correlated with the roentgen findings. A bibliography of selected references on the subject is also appended. American radiologists who have mastered the French language will undoubtedly enjoy reading Sayé's monograph.

ABSTRACTS OF CURRENT LITERATURE

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A. L. Hart, M.D.
H. W. Hefke, M.D.

E. T. Leddy, M.D.
H. C. Ochsner, M.D.
C. G. Sutherland, M.D.

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BONE DISEASES (DIAGNOSIS)

A Rare Localization of Köhler's Disease. Curt Kremser. *Röntgenpraxis*, May, 1932, IV, 394-402.

Since Köhler described the so-called aseptic necrosis of the navicular bone, similar changes have been described in other bones (Perthes, Preiser, Kienhöck, and others). This disease has been seen in the patella by a few authors. Two such cases are described in this article. Both were children, 5 and 8 years of age, showing complete necrosis of the patella. The clinically normal patella on the other side also showed evidence of necrotic changes. A history of trauma was not present. The differential diagnosis is usually not difficult. Tuberculosis may occasionally produce a similar clinical picture, but the roentgenogram can easily differentiate the two. In both cases the condition was cured, in one child without even putting the patient to bed.

H. W. HEFKE, M.D.

Further Notes on Pituitary Basophilism. Harvey Cushing. *Jour. Am. Med. Assn.*, July 23, 1932, XCIX, 281-284.

Twelve examples of a peculiar and clinically unmistakable polyglandular syndrome were recently reported by the author. The disorder is characterized by a rapidly acquired plethoric adiposity, affecting the face, neck, and trunk, the extremities being spared. It is associated in women with hypertrichosis and amenorrhea. Other characteristic features are vascular hypertension, purplish striae cutis distensae of the abdomen, and acrocyanosis, with cutis marmorata of the extremities. It is often accompanied by hyperglycemia, occasionally by polycythemia, a peculiar softening of the bones of the skeleton being commonly found at autopsy. In its extreme forms, the malady has more often been encountered in young adults, and the average duration of life has been over five years. The disease in most instances has been ascribed to a primary adre-

nal disorder for the reason that cortical hyperplasia is not an uncommon postmortem observation. At autopsy five of eight cases had an unsuspected pituitary adenoma; the fact that three of them were unmistakably composed of basophilic elements made it probable that the pituitary lesion was the primary cause of the syndrome.

Roentgenologic studies showed a peculiar mottled atrophy of the bones, particularly apparent in the cranial vault. The dorsal kyphosis, associated with compression of several of the vertebral bodies, was more marked in the fifth and seventh. There were six lumbar vertebrae, two of them, the fourth more particularly, showing definite compression. In contrast to the general appearance of atrophy, the margins of the vertebral bodies appeared eburnated. The epiphyses of the long bones were normal for the age, but appeared denser than normal. The humeri and the radii showed mottling and enlargement of the trabeculae and thinning of the cortical portions of the bones. Similar changes were present in the ribs, and surprising increase in calcium output was found. A series of high voltage roentgen treatments resulted in prompt improvement in the condition of the patient described.

C. G. SUTHERLAND, M.D.

The Roentgen Diagnosis of the Mandibular Joint. C. Parma. *Röntgenpraxis*, August, 1932, IV, 633-649.

The present-day diagnostic methods for diseases of the mandibular joint are still rather unreliable. In all other joints a roentgenologic examination is usually of greatest importance; however, it has not been as successful in the case of the mandibular joint, due principally to technical difficulties and the inability to obtain a good roentgenogram. The author suggests a new method.

He uses as short a focal skin distance as possible. The joint closest to the focus then appears so greatly enlarged on the film that it does not seem to show at all, and one gets good detail of the joint which is nearest the film. The projection is straight lateral, and the mouth must be kept wide open. If the patient is too close to the tube, there is, of course, the danger of electrical accidents, which can be avoided by low voltage (from 40 to 50 volts) and good grounding. The author shows on films, taken on patients and skeletons, the normal and abnormal appearances of the mandibular joint.

H. W. HEFKE, M.D.

A Case of Ochronotic Alkaptonuria, with Considerable Skeletal Changes. Ehrlich. October, 1932, IV, 865-870.

Ochronotic alkaptonuria, a comparatively rare disease, is an anomaly of the intermediary protein metabolism, with typical urinary findings. Roentgenologic findings of bone changes have been de-

scribed. A case is reported, demonstrating the typical clinical and roentgenologic picture. The vertebrae and pelvis show a uniform atrophy, and the intervertebral spaces are narrowed, the discs being partially calcified. Hypertrophic changes are evident. Therapeutic methods have not been successful so far.

H. W. HEFKE, M.D.

CANCER (DIAGNOSIS)

Lung Cancer in Miners. Editorial. *Jour. Am. Med. Assn.*, Aug. 6, 1932, XCIX, 478, 479.

Primary cancer of the lung for a long time was listed among the rare diseases; however, bronchogenic cancer has now become one of the common forms of cancer both in the clinic and the necropsy room. Prominence has been given to the Schneeberg group of cases in the Saxon mines of the Erz Mountains. In the Joachimstal mines on the Bohemian side of the Erz Mountains, only twenty miles from the Schneeberg mines and the source of the pitchblende from which the first supplies of radium were obtained for use in therapeutics, an investigation revealed that there was a high incidence of pulmonary cancer. Postmortem examination of the bodies of 13 Joachimstal miners, who died during 1929 and 1930, revealed that nine had died of primary carcinoma of the lung. In the year following, 12 miners died, in nine of whom the clinical diagnosis was pulmonary cancer. Six of the nine men had been pensioned off several years before dying of lung cancer.

Inhalation of arsenic dust might account for the Schneeberg cancer, but the facts that in both the Schneeberg and Joachimstal mines, large radium deposits exist, and that the air contains much radium emanation (up to 50 mache units), arouse the suspicion that herein lies the inciting agent of the lung cancers. The miners themselves state that the discovery of a vein rich in uranium is always followed some years later by a strongly increased mortality among them, but analysis of a part of a cancerous lung from one of the miners revealed no radioactivity, no arsenic, cobalt, or uranium.

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CHEST (DIAGNOSIS)

Congenital Left Cystic Lung, with Aplasia of the Lower Lobe. P. Iacchia. *Röntgenpraxis*. October, 1932, IV, 873-878.

Marked congenital anomalies of the structure of an entire lung are comparatively rare. The author believes that some cases of bronchiectasis are of congenital origin. Usually one finds in aplasias of parts of the lung a displacement of other organs to fill the space otherwise left empty. Ring shadows may be seen in congenital cystic lungs, but an examination after intratracheal instillation of an

iodized oil will clear up the situation much more readily.

In a patient with clinical symptoms of bronchiectasis a flat chest film showed deviation of the trachea to the left, with displacement of the heart and mediastinum toward the same side. The upper portions of the left lung showed many ring-like structures. There was definite relaxation of the diaphragm, so that the stomach filled the lower portion of the left thorax. Bronchographic studies showed an absence of lung structure in the left lower lobe, there being a system of cavitations. The upper lobe contained multiple cystic areas and cavities. The thorax itself was not deformed. The pleural space was free, this being another reason for the diagnosis of congenital bronchiectasis and aplasia, rather than an acquired condition.

H. W. HEFKE, M.D.

Silicosis in a Tuberculosis Hospital. J. R. Head and S. H. Rosenblum. *Jour. Am. Med. Assn.*, Sept. 10, 1932, XCIX, 915, 916.

A clinical and statistical study has been made in a district in which the industries do not especially predispose to pneumoconiosis. Five hundred consecutive male patients admitted to the hospital were carefully questioned, particularly as to industrial history. Among the 500 there were 17 (3.4 per cent) who had definite silicosis. The average age was 45 years; more were under 30 years of age, the highest incidence occurring in the fifth decade. Mining and sandblasting accounted for all save one of the 17 cases (12 miners and four sandblasters), the remaining one having shoveled sand in a foundry for six years. Only four of the patients developed symptoms while still engaged in dusty work; in the other twelve there was an average interval between cessation of work and the onset of symptoms of 10.75 years, with low and high limits of four and 18 years, respectively. The average duration of exposure was eight years, with low and high limits of one and 35 years, respectively.

The roentgenogram is of first importance in the diagnosis. In this series the sputum was positive in all save five cases. If a patient has silicosis without tuberculosis, he should not be allowed in a tuberculosis hospital, much less confined there, as no other group of individuals is so susceptible to tuberculosis.

C. G. SUTHERLAND, M.D.

CHEST (GENERAL)

Massive Collapse of the Lung, with Spontaneous Pneumothorax. William H. Crede. *Med. Bull. Veterans' Administration*, April, 1932, VIII, 280-286.

In 1890, Pasteur reported 15 cases of massive collapse of the lungs, occurring in children who were the victims of diphtheritic paralysis. He believed that the condition is always the result of failure of

respiratory power. Massive collapse was noted as a result of wounds of the chest during the World War. Cases were also reported which occurred as the result of the following: Wounds of the pelvis; myositis; inflammation of the pleura; obstruction of a bronchus by a foreign body; paralysis of the respiratory muscles; extrabronchial pressure due to neoplasms, aneurysms, or enlarged glands.

The onset of massive collapse is usually sudden, although when it occurs in a toxic tuberculous patient it may be overlooked. It is of interest that the onset of collapse may result in the relief of a previous harassing cough and that, on the other hand, if no pulmonary disease is present, a weak irritating cough may appear. Dyspnea may be present and cyanosis is not marked, as a rule.

The physical signs resemble pneumonia. In the case of collapse, however, inspection will reveal retraction or no fullness of the intercostal spaces. Displacement of the heart toward the affected side, which occurs rapidly, is noted by palpation. Absolute dullness is elicited if complete collapse of a considerable portion of lung tissue is present. This dullness may confuse collapse with the presence of fluid, but the position of the apex beat will differentiate these conditions. However, it must be checked by x-ray examination, since fluid exerting pressure may be the cause of collapse on the same side and the rather typical heart shift to the affected side may be distorted. Massive collapse produces an elevation of the diaphragm on the affected side, and, therefore, when it is present on the left an increase upward of gastric resonance occurs. Auscultation reveals absence of all breath sounds and of vocal resonance.

J. N. ANÉ, M.D.

CONTRAST MEDIA

An Unfortunate Bronchography. Björn Köhler. *Acta Radiologica*, 1932, XIII, Fasc. 1, pp. 54-56.

The author reports the case of a boy, 9 years old, who was studied by him. The lad had had erythema nodosum at the age of 15 months. He was subject to colds and at the age of 5 years, after having measles, developed a cough and was found to have enlarged tracheobronchial nodes. The von Pirquet was positive. At 9 years he had an acute illness, with fever and cough, which lasted more than four weeks. Because of slow convalescence and persistent cough, he was admitted to the hospital for lipiodol studies.

On two successive days lipiodol was injected (exact method not stated) in the routine way, but no opaque material could be seen in the lung fields. After three days, injection was again attempted. Roentgen examination now showed a mass of lipiodol in the central part of the neck. It reached the posterior mediastinum along the esophagus; some

nal disorder for the reason that cortical hyperplasia is not an uncommon postmortem observation. At autopsy five of eight cases had an unsuspected pituitary adenoma; the fact that three of them were unmistakably composed of basophilic elements made it probable that the pituitary lesion was the primary cause of the syndrome.

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of it collected along the carotids and some below the thyroid cartilage, while other portions extended outward between the subclavian artery and the brachial plexus and downward anteriorly over the pleura. During six months' observation, no change has occurred.

The author discusses the possible ways in which the lipiodol could have escaped into the soft tissues of the neck. He inclines to the opinion that a surgical emphysema occurred which opened up spaces between the fascia and layers of connective tissue and that the lipiodol worked its way into these spaces during the child's attacks of coughing.

A. L. HART, M.D.

Intravenous Pyelography with Use of Iopax. Chester D. Allen and Samuel L. Edwards. *Med. Bull. Veterans' Administration*, April, 1932, VIII, 277-279.

The authors discuss the indications and limitations of intravenous pyelography. Theoretically, the intravenous method of urography is ideal in all cases, for the pain and colic so often associated with the retrograde method are avoided. In those cases in which the retrograde method is impractical or impossible, the intravenous method is of considerable value, but it should never replace retrograde pyelography in the average case.

The shadows produced by the intravenous method are faint, with a considerable loss of detail in many cases. It cannot be compared to the Graham-Cole method for visualization of the gall bladder. The shadow of the gall bladder consists of simple curves, while that of the kidney pelvis is quite complicated, as the outline of the minor calyces depends on the contour of the renal papilla. The gall bladder is a single storage organ receiving the dye from the liver, while the pelves are for collection and transmission and receive the dye from the two kidneys. In certain urologic conditions the urine passes rapidly through the kidney pelves, rendering very poor visualization of the pelves in general and the minor calyces in particular.

The authors believe that the interpretation of the pyelogram should be done by the urologist and radiologist after careful discussion and consideration of all data in the case.

J. N. ANÉ, M.D.

CYSTS

Hydatid Cyst of the Lung. Alfeu Bica de Medeiros and Saint Pastous. *Rev. Radiol. Clinica*, February, 1932, I, 159-166.

The authors report a case of hydatid cyst of the left lung. The clinical diagnosis of cyst was sup-

ported by the laboratory and x-ray examinations and confirmed by operation. Simple small cysts are characterized in the roentgenogram by a uniformly opaque, more or less circular, area with very sharp edges. Large cysts with congestive or inflammatory reactions surrounding them are not so sharply defined. Benign and malignant tumors of the thorax and lung, encysted pleurisy, and aneurysm of the aorta give findings resembling those of hydatid cyst. Hydatid can not be differentiated from tuberculous cavities.

E. T. LEDDY, M.D.

Suprapituitary Cyst. J. H. Gibbens. *Proc. Roy. Soc. Med.*, March, 1932, XXV, 722.

A girl, five years of age, had nocturnal attacks of headache and vomiting for a year. On roentgen examination there was found a partial destruction of the sella turcica, especially of the posterior clinoid processes. No abnormal calcification was visualized. The condition of the patient was temporarily improved following x-ray therapy.

H. C. OCHSNER, M.D.

THE ESOPHAGUS (DIAGNOSIS)

Esophageal Varices. A. Beutel. *Acta Radiologica*, 1932, XIII, Fasc. 5, 527-532.

Most of these cases are examined for gastric ulcer or cancer, suspected because of sudden hematemesis. Wolf, in 1928, first described two cases diagnosed at x-ray examinations. The author advises the use of a thick barium mixture which will stick in the ridges of the mucosa. The normal mucosa of the esophagus is characterized by delicate longitudinal folds. When varices are present, one sees instead wavy bands of transparency bordered by thin lines of barium. These may take a longitudinal or a horizontal direction. One also sees, occasionally, rounded areas of transparency.

The changes in the mucosal relief and contour may be confused with tumor defects, particularly the flat, scirrhous carcinoma. The fact that varices usually involve a larger portion of the esophagus than does cancer helps in the differential diagnosis. Doubtful cases should have repeated examinations. Varices also often change their form with breathing. When varices are present, the mucosal relief films of the esophagus usually show it wider than normal. The author reports two cases diagnosed by x-ray examination. One of these was confirmed by esophagoscopy; the other by both esophagoscopy and autopsy. Both of these patients had enlarged livers and spleens.

A. L. HART, M.D.

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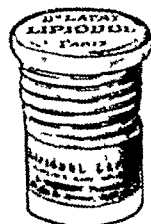
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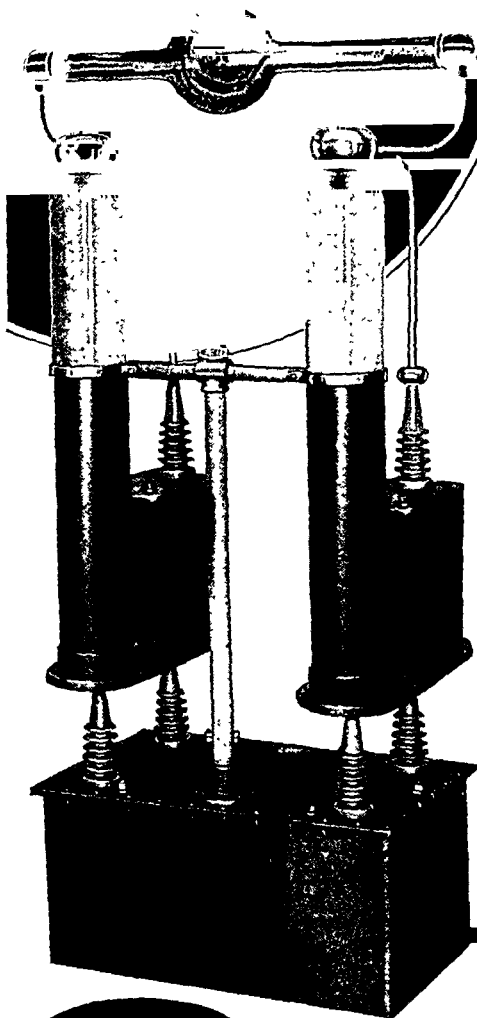
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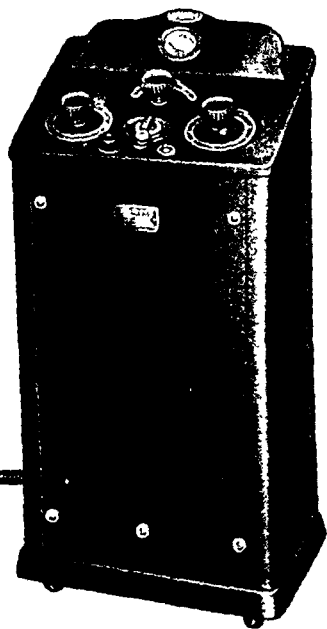
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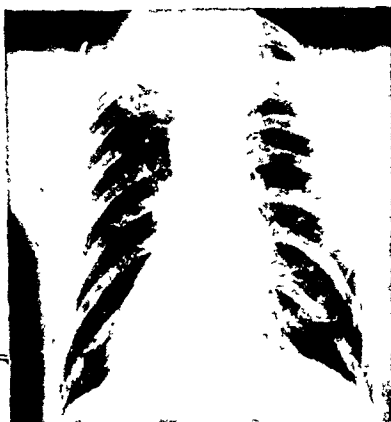
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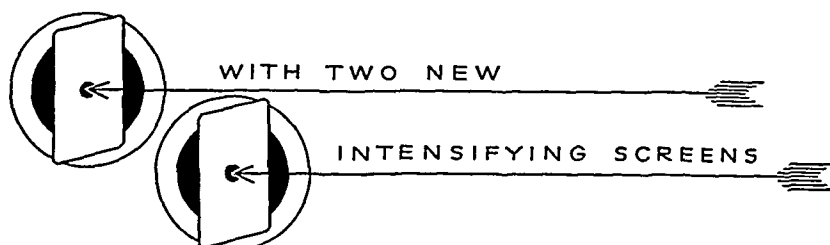
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A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Owned and Published by
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As its Official Journal

EDITOR

LEON J. MENVILLE, M. D. - - - NEW ORLEANS, LOUISIANA

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FEBRUARY, 1933

Volume XX

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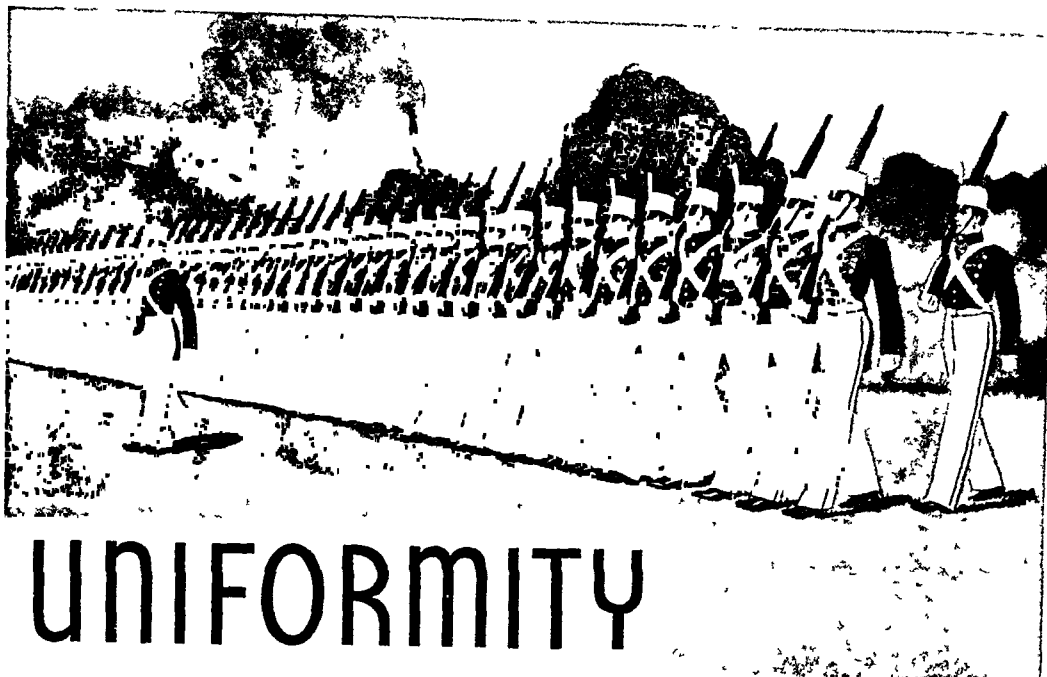
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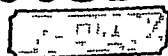
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A METHOD FOR THE LOCALIZATION OF FOREIGN BODIES IN THE EYE¹

By ROY KEGERREIS, M.D., CHICAGO

THE localization of foreign bodies within the eye by means of X-rays has gained tremendously in importance with the increase in industrial accidents. It is impossible to demonstrate roentgenographically a foreign body in a large percentage of patients who are referred for examination. As a rule, preliminary roentgenograms are made in order to determine whether or not a foreign body is present, to eliminate the painstaking work which is necessary for an exact localization. Many workers take postero-anterior stereoscopic views of the skull for the preliminary examination, but there are various kinds of non-metallic foreign bodies which are liable to be invisible with this type of technic because of the absorption of the X-rays by the overlying brain and calvaria. It is better practice to take one postero-anterior view of the entire skull to show both eyes, since adjacent sinus, dental, or other pathology is frequently present and it is always advantageous to be able to compare the other side. An oblique lateral view, with the injured side nearest the film and the rays coming slightly from the front, should also be taken; in this manner a maximum of contrast is obtained. The two roentgenograms will enable a preliminary estimate to be

made of the size, shape, location, and character of the foreign body, if it is apparent.

The patient may be examined by fluoroscopy, but the lack of evidence of the presence of a foreign body should not be considered as evidence in a positive sense. If the foreign body is opaque to X-rays and is of considerable size, fluoroscopy is frequently helpful as a means of preliminary localization.

It is common practice to take lateral and either anteroposterior or postero-anterior views when studying fractures or other traumatic lesions of the extremities. In such work, the bodies to be localized are frequently multiple and the necessary precision is more of a gross character than is the case in work with the eye in which the foreign body is usually quite minute and the localization must be as exact as possible. In examining an extremity, right-angle views are very helpful in giving a true picture of the conditions. These same advantages do not hold for the work of localization of foreign bodies in the eye, because it is often exceedingly difficult, or even impossible, to identify corresponding parts of single or multiple foreign bodies. The difficulty in identifying corresponding parts does not exist, to a great extent, if the tube shift is such that there is an angle of, say, 30° between the beams of X-rays, yet the accuracy of the

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

localization from measurements of shift of images is only slightly decreased. It might be pointed out that the accuracy of localization of foreign bodies in the eye is not limited by the accuracy of the measurements on the roentgenogram, but, rather, because of

the derivation of such methods, just as is the analogous case with graphic solutions.

SWEET LOCALIZER

The apparatus which was developed by the late Dr. Sweet is probably the most gen-

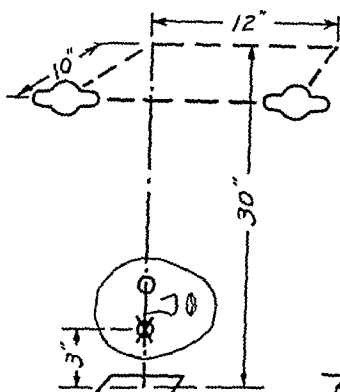


Fig. 1-A.

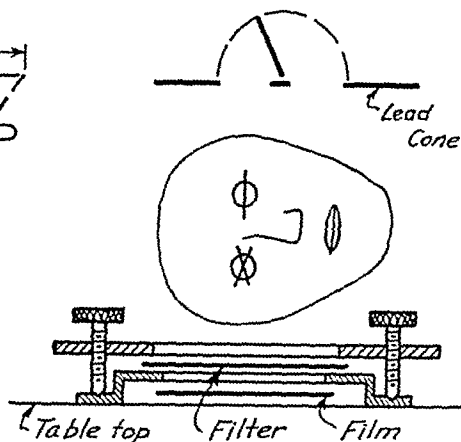


Fig. 1-B.

the less apparent inaccuracies of alignment and the unknown factors of individual anatomic variation. It should be noted that "the actual localization is made with reference to the marker in front of the eye and not with reference to the structures of the eye."

GENERAL METHODS OF LOCALIZATION

All methods depend on one or another system of three-dimensional triangulation; two roentgenograms are made and measurements are taken from them. Graphic solutions, which have been used generally, are most beneficial when the construction is carried out and superposed on data that already exist on the sheet of paper. The necessary computations of analytic methods for the determination of the position of a foreign body may be made by one who does not possess sufficient working knowledge of geometry and trigonometry to understand

generally accepted and used in this country. Excellent work can be done with it but

- (1) The cost of the apparatus is considerable;
- (2) The apparatus is heavy to handle and rather bulky to have about;
- (3) It is not feasible to observe the injured eye while the exposures are being made;
- (4) The terminals of the X-ray tube are rather near the patient.

The following dimensions are approximated in this apparatus:

- 16.7 in., perpendicular distance from the target to the plane of the photographic emulsion;
- 3 in., center of the eye to the plane of the photographic emulsion;
- 7 in., tube shift between exposures;
- 25°, angle between the X-rays and the frontal plane of the patient.

The obliquity of the X-rays with the

frontal plane of the patient's face is used in order to "throw out" the shadow of the opposite eye, secure a bone-free exposure of the cornea, and have the X-rays penetrate a minimum of tissue. All of these conditions are very desirable.

TELERRADIOGRAPHY

Teleradiography assumes that

- (1) The X-rays approach parallelism;
- (2) There is good definition;
- (3) There is very little magnification or distortion in the photographic image.

These conditions are secured by relatively long target-film distances, short object-film distances, and, to a certain extent, by the use of an X-ray tube with a small focal spot. Very often the perpendicular distance from the object to the plane of the film is not considered sufficiently. The ratio of the target-film distance to the object-film distance gives an index of the effective parallelism of the rays.

A recent article by Ahlbom (1), which very thoroughly reviews the literature on foreign body localization in the eye, presents a new teleradiographic triangulation method for the localization. Two views are taken at right-angles with a target-plate distance of 2.75 meters, but the object-plate distances are about 12.5 and 25 centimeters. There are then target and object distance ratios of approximately $275 \div 12.5 = 22$ and $275 \div 25 = 11$. In the Sweet localizer the corresponding ratio is $16.75 \div 3 = 5.6$. In the arrangement which is being suggested (Fig. 1-A) the ratio is $30 \div 3 = 10$.

It is seen that the parallelism of the rays, according to this ratio measurement, is about twice that of the Sweet method and compares favorably with that of Ahlbom's so-called teleradiographic method, yet the target-film distance is considerably less than one-third his value.

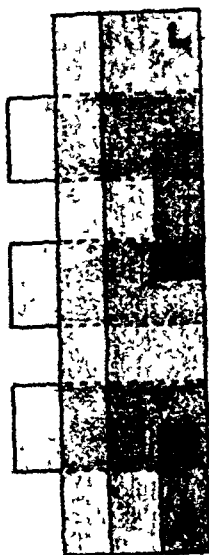


Fig. 2-A.

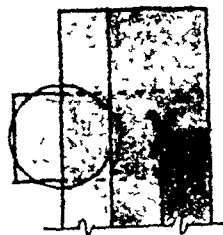


Fig. 2-B.

STEPPED FILTER

Ahlbom has suggested the use of a wedge-shaped filter of aluminum to avoid the over-exposure of certain areas and, in particular, to cause the cornea to be apparent on the roentgenograms. This is a very excellent method of eliminating the over-exposure of certain parts. A similar adaptation of a filter is made in the method which is being described. However, the filter, rather than the photographic emulsion, is used as the reference plane and it is made stepped so that a system of rather special rectangular co-ordinates is apparent on the roentgenograms (Fig. 2-A). Although the stepped filter and the film should be parallel, this need be only approximate, since measurements are taken from the roentgenograms by means of proportional scales that automatically correct for any possible distortion which may exist, because of non-parallelism or because of expansion or shrinkage of the film. The amount of irregular distortion of a roentgenogram within any one of the rather small elemental rectangles will, quite obviously, be negligible. The co-ordinate system is apparent on the roentgenograms,

but it is not obtrusive and, in general, the filter tends to make the foreign body more conspicuous without there being any chance of occluding it.

Copper is employed as the filtering mate-

filter as to be in a line perpendicular to it while the patient is being positioned. The stepped filter is held by spring friction and can be moved about in its plane quite easily. The head is raised or lowered and

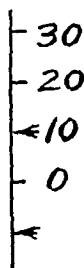


Fig. 3-A.

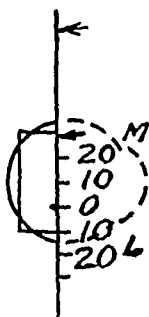


Fig. 3-B.

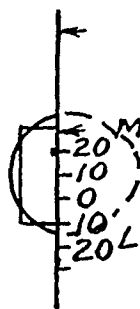


Fig. 3-C.

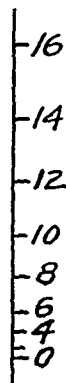


Fig. 3-D.

rial, rather than aluminum, since it can be much thinner for the same absorption. As a result, the edges of the co-ordinate rectangles are definite. The filter varies from $1/20$ to $1/2$ mm. in thickness.

ALIGNMENT OF PATIENT

The patient's head, with the injured side down, rests on a framework which is independently supported by three levelling screws (Fig. 1-B). The head is pressed down firmly by means of sandbags and it can be raised, lowered, or even tilted by manipulating the three levelling screws.

The visual axis is not the geometric axis of the eye and, for that reason, the patient should gaze 5° nasalward in the median horizontal plane.

The fiducial marker which is placed 1 cm. before the injured eye is a metal cross that shows on the roentgenograms. The marker which is placed before the uninjured eye is a straight edge of non-opaque material. The two markers are so fastened to the stepped

the stepped filter, with the attached fiducial markers, is moved about until the wire cross is exactly 1 cm. in front of the middle of the cornea of the injured eye; the head is tilted until the upper marker is also 1 cm. away from the cornea of the uninjured eye and passes directly before its center. The alignment of the filter, fiducial marker, patient's head, and target of the X-ray tube has not been correct if the relations shown in Figure 2-B do not exist in the roentgenograms. It is thus seen that a rather good check can be had almost at a glance, since some of these relations can be made out on the roentgenogram.

A sheet of lead is placed above the patient's head to "cone down" the X-rays.

MEASUREMENT AND CALCULATIONS

Three co-ordinates are required to locate a point in space; the specification of the position of a foreign body in the eye is no exception to this law. The three co-ordinates are derived from measurements which are

taken from the two roentgenograms by means of special proportional scales that automatically make the dimensions correspond to those in the plane of the stepped filter. Numerous scales, which vary in mag-

DISTANCE FROM SAGITTAL PLANE, LATERAL OR MEDIAL LOCATION

The distance of the foreign body from the sagittal plane of the eye is obtained by

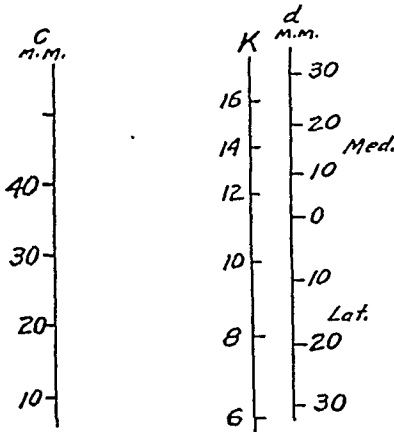


Fig. 4-A.

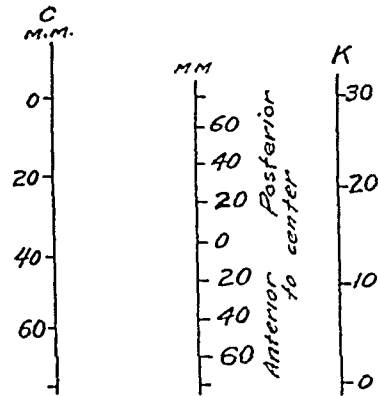


Fig. 4-B.

nitude by about 1 per cent, are provided and measurements are made with the scale, which, in the desired direction, exactly match the width of the elemental rectangle that contains the image of the foreign body.

DISTANCE FROM MEDIAN HORIZONTAL PLANE, VERTICAL LOCATION

The distance that the foreign body is above, or below, the median horizontal plane of the eye can be measured directly from the first roentgenogram, in which the target of the X-ray tube was on a level with the eye and 10 inches anterior to the fiducial markers. The scale is calibrated directly in millimeters and is "laid out" on the assumption that the rays through the sagittal plane are parallel (Fig. 3-A). This is, admittedly, an approximation, but it entails a possible maximum error of only about one-fifth millimeter and it simplifies the necessary mathematical manipulations.

means of two measurements, one from each of the roentgenograms (see appendix below). The measuring scale is placed vertically so that its 0 coincides with the image of the foreign body on the first roentgenogram in which the target of the X-ray tube was on a level with the injured eye. The place on the scale at which it crosses the lower edge of the horizontal filter band is noted (Fig. 3-B). A scale which has been found to match the width of the horizontal filter band in the other roentgenogram in the region of the image of the foreign body is so placed that the value which was just previously noted on the scale over the first roentgenogram is over the corresponding filter band edge, and the distance from the foreign body to the sagittal plane can now be read directly from the scale (Fig. 3-C).

ANTEROPOSTERIOR LOCATION

The distance of the foreign body from the sagittal plane and the horizontal distance of the image of the foreign body from the im-

age of the fiducial marker are used to make the calculation of the anteroposterior location. The measurement of the horizontal location of the image of the foreign body is made from the edge of one of the vertical

genograms when the patient gazes in different directions will produce a shift of the image of the foreign body if it is within the eyeball, fastened to it or its appendages. No motion will be shown if the foreign body lies in the axis of rotation, or if the two positions are in the same ray, causing the two images to be superposed on the roentgenogram, even though rotational motion has taken place. The underlying principles of this method have been fully discussed by several authors.

DISTANCE FROM THE CENTER

The ophthalmologist who receives the report is usually desirous of knowing at what point the wall of the eyeball is nearest the foreign body, and how near it is. The square root of the sum of the squares of the three distances which have been found gives the radial distance from the center. This, subtracted from the radius of the eye, gives the distance from the outside of the eyeball. A special scale (Fig. 3-D) is used to perform the calculation. With it, three lengths are laid off end-to-end, which are proportional to the squares of the distances from the center of the eye. The combined total length of the three lengths, when measured by the scale, gives the desired square root of the sum of the squares. The diameters of eyes vary considerably, but, as a starting point, an eyeball with a diameter of 24 mm. is assumed, with a corneal bulge 1 mm. thick and 8 mm. radius. Normal eyes will vary nearly as much as 10 per cent from this. Injured eyes may vary more, because of edema, hemorrhage, shrinkage, or even collapse on account of the actual loss of fluid. The referring ophthalmologist is quite obviously the one to allow for such conditions.

RÉSUMÉ

Frequently the location of the foreign body is determined to be such as to leave some doubt as to whether it is within or without the orbit. The making of roent-

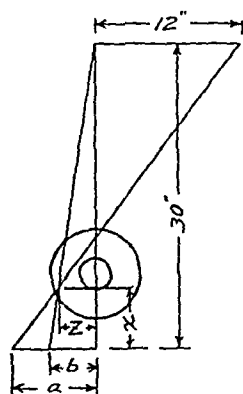


Fig. 5-A.

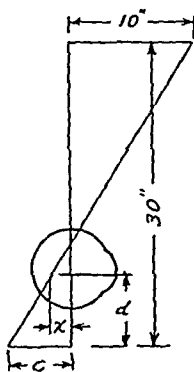


Fig. 5-B.

filter bands. This measurement should be the same on each of the two roentgenograms. If the latter are not the same within the general accuracy of the work, the exposures should be repeated. This, of itself, is a good check on the accuracy of the set-up of the apparatus.

The anteroposterior location of the foreign body is obtained by means of a so-called "alignment chart" and a graphic subtraction (Fig. 4). The two known values on the outer scales of the alignment chart are connected by a straight edge or stretched thread, and the anteroposterior location is found by subtracting the reading of the middle scale (K) from the measured horizontal distance given above. The subtraction is accomplished by connecting the corresponding values of the outer scales of the chart of Figure 4-B.

PHYSIOLOGIC METHOD

In the method which is being described, the position of the patient is such that the injured eye can be observed during the ex-

posures. It is suggested that this be done by means of a short range telescope with a magnification of about two or three diameters.

It seems that there have been no reported cases in which the foreign body was not rigidly fixed inside the orbit and did not turn consistently with it. Such a case is a possibility and should be considered if the results appear bizarre.

Any difference in the sharpness of the images in the two roentgenograms should lead to rejection of them, because poor definition is almost sure evidence of motion. There is always a great advantage in repeating the work, since then a check is possible.

If the foreign body is in the cornea or adjacent structures, valuable information may be secured by inserting a small film above, below, or alongside of the eye and using the so-called "soft tissue technic" (2).

The principle embodied in the stepped filter may be applied to any method of localization.

This method should prove satisfactory because of the following conditions:

- (1) Films with or without intensifying screens may be used. No glass plates, special envelopes, or developing holders are required.
- (2) The film is near the injured eye and the target-film distance is relatively great.
- (3) The stepped filter and fiducial markers are easily adjusted.
- (4) There are refinements in aligning the patient's head.
- (5) It is necessary to position the patient only once; he need not be disturbed between exposures.
- (6) The X-rays penetrate a minimum of tissue.
- (7) Scatter is minimized by a coning down of the X-ray beam to a minimum.

- (8) The cornea is made apparent.
- (9) The injured eye is observed while the exposures are made.
- (10) Inherent checks exist.
- (11) A complete specification is secured.
- (12) The required apparatus is relatively simple and inexpensive.
- (13) There is ample clearance between the high voltage conductors and the patient.

APPENDIX

Distance from the Sagittal Plane, Lateral or Medial Location (Fig. 5-A).—By the law of similar triangles the following proportions may be set up:

$$(1) \quad (30 - x) : z :: x : (b - z)$$

$$(2) \quad (30 - x) : (z + 12) :: x : (a - z)$$

Equating the product of the means to the product of the extremes gives:

$$\text{From (2)} \quad zx + 12x = (a - z)(30 - x)$$

$$(1) \quad zx = (b - z)(30 - x)$$

Subtracting

$$12x = (a - b)(30 - x)$$

Solving for x

$$x = 30(a - b) / 12 + (a - b).$$

We measure a and b on the roentgenograms. This expression for the distance of the foreign body from the plane of the filter depends on only one variable, $(a - b)$, and, accordingly, a scale can be constructed to give x in terms of the difference between the two lengths a and b (Figs. 3-B and 3-C). The scale may be calibrated in distance from the sagittal plane by the subtraction of a constant from the value of x .

Anteroposterior Location (Fig. 5-B).—By the law of similar triangles

$$d : (c - x) :: 30 : (10 + c)$$

Equating the product of the means to the product of the extremes and solving for x gives

$$x = c - (d/30)(10 + c).$$

We secure c by measurement and d by calculation. The expression on the ex-

age of the fiducial marker are used to make the calculation of the anteroposterior location. The measurement of the horizontal location of the image of the foreign body is made from the edge of one of the vertical

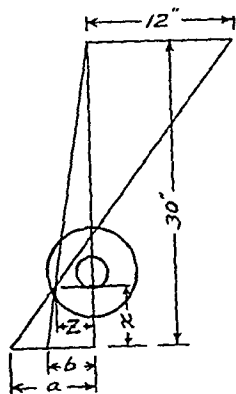


Fig. 5-A.

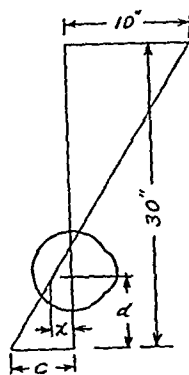


Fig. 5-B.

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genograms when the patient gazes in different directions will produce a shift of the image of the foreign body if it is within the eyeball, fastened to it or its appendages. No motion will be shown if the foreign body lies in the axis of rotation, or if the two positions are in the same ray, causing the two images to be superposed on the roentgenogram, even though rotational motion has taken place. The underlying principles of this method have been fully discussed by several authors.

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In attempting to make the diagnosis of small intestinal lesions, the roentgen-ray technic is of extreme importance. *First*, the patient must be examined in the upright posture. *Second*, begin to look for abnormalities in the small intestinal pattern from the two and one-half to the six-hour period. They are often encountered just about the time the last part of the barium meal leaves the stomach. *Third*, secure a film of the suspicious area at once and continue to watch for other overfilled loops, recording at once. The shadows are apt to be evanescent. It is a mistake to expect them to be persistent. Remember that you are searching for evidence of partial and not complete obstruction.

The vast majority of adhesions are post-operative in character but some are produced by former inflammatory processes. I have designated the usual adhesions that follow appendectomy as *Grade 1*. In this type the coils of the terminal ileum are matted together, *i.e.*, adherent to each other. No symptoms are produced by this form.

In adhesions of *Grade 2*, one or more bands are formed which attach a coil of the gut to some neighboring organ or to the abdominal wall. This type may produce no symptoms; however, it forms a trap that may catch a loop of the bowel and produce acute obstruction. Often a patient gives a history of several attacks of partial obstruction, *with complete absence of symptoms between the attacks*. The most careful X-ray examination may fail to disclose these bands, but the alert observer will usually find atypical dilated coils.

Adhesions of *Grade 3* form definite bands which bind down the intestine and form a partial stenosis of the lumen and interfere with function, as illustrated by the adhesive bands that constrict the terminal ileum. This type is more easily demonstrated by roentgen examination. The symptoms are usually dull pain located in

the region of the constriction, intermittent in character, often nausea and anorexia. A history of partial attacks of obstruction is usually obtained.

It is obvious that adhesions of all three types may exist in the same patient.³

The *post-operative treatment* is of extreme importance. We must avoid everything that might incite peristaltic movement of the small intestine. During the first 72 hours after operation the following rules must be rigidly enforced:

1. No food or water to be given by mouth. Frequently moisten the tongue and lips with cold water to maintain salivary secretion, thereby preventing possible ascending infection, particularly of the parotid gland.
2. The patient to be sustained by the free use of intravenous glucose and saline solution.
3. No vomiting to be permitted. The Levin intra-nasal catheter is to be kept in the stomach and the contents siphoned until all danger from accumulation of gastric secretion is over.
4. Permit no enema or passage of the colon tube.
5. Permit no laxative to be given.
6. The patient is to be kept under the constant influence of morphine, given hypodermatically by the "overlapping method," *i.e.*, every four to six hours in doses sufficient to produce mental calm and physical rest. The dosage will vary from 1/12 to 1/4 grain. Care must be exercised that the patient does not emerge from the morphia influence until the 72-hour period has elapsed. After this time the usual symptomatic treatment is employed.

In my series of patients, 20 cases of diverticulum of the duodenum and 12 cases of diverticulum of the jejunum were encountered. None of the patients developed symptoms that could be traced to the di-

³Films were shown from which the essayist demonstrated the three grades differentiated.

treme right is calculated by means of the alignment chart (Fig. 4-A).

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- (2) WIESER, S.: Weitere Mitteilungen über die skelettfreie Röntgenaufnahme des vorderen Bulbusabschnittes nach Prof. Dr. Vogt. *Klin. Monatsh. f. Augenheilk.*, Aug. 31, 1928, LXXXI, 234-253.

DISCUSSION

DR. ROBERT R. NEWELL (San Francisco): I would like to know whether the triangulation of that foreign body is done with reference to the height above the surface of the film or if it is done in regard to the eyeball. Does the shadow of the eyeball show with sufficient clearness so that you measure its relation to the height of the eyeball?

One needs, for localization of foreign bodies in the eye, better than millimeter accuracy. It often makes all the difference in the world whether a foreign body is inside or outside the eyeball. Inasmuch as many foreign bodies hang up against the sclera, that question comes up very often.

I would like to ask if you tried your localization on known foreign bodies in the eye. Occasionally I have checked the position of a foreign body in the eye by putting marks on the eye. Take some thin silver wire and wrap it into a spiral, then clip off pieces to make very small rings of about a millimeter in diameter, open just wide enough, which you

can clip to the conjunctiva at the limbus. I have had occasion to put on two of these at opposite ends of a diameter of the cornea, and localized them and the foreign body at the same time, in order to be sure of the position.

DR. GENTZ PERRY (Evanston, Ill.): I was quite impressed with the nicety with which the position of the head may be adjusted with this apparatus. I think that is really a very nice point of improvement, as shown by this technic.

I would like to ask the essayist, in relation to the question just asked, if the foreign body is within the eyeball. The essayist mentions the movement of the foreign body as shown by different views, if they are made in relation to the movement of the eyeball. He uses the term "orbit." I am not quite certain whether, in his paper, he means the bony orbit or the eyeball. I would like to have him bring out that point.

I am quite impressed with what should be a very accurate localization. I think that there are certain improvements in the technic shown that are well worth our consideration.

DR. KEGGERREIS (closing): It can be stated that the filter plane is taken as the plane of reference.

The use of a wire loop, which Dr. Newell has originated in localization, is very excellent and has many advantages. Its only disadvantage, as I see it, is that an additional very slight trauma is inflicted on the outer surface of the injured eye.

ROENTGEN DIAGNOSIS OF LESIONS IN THE SMALL INTESTINE¹

By HORACE W. SOPER, M.D., ST. LOUIS, MISSOURI

SINCE publication of an article in August, 1929,² I have been able to formulate more accurately the interpretation of atypical patterns in the small intestine as

they appear upon the X-ray films. Increased experience has led to the diagnosis of a larger number of cases presenting obscure symptoms. Differential diagnosis between diverticula, adhesions, and new-growths is of chief interest and I shall confine my paper to that subject.

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

²*Am. Jour. Roentgenol. and Rad. Ther.*, August, 1929, XXII, 107-119.

interarticular space, and, finally, fusion of the articular surface with complete ankylosis. There was, or still is, present, somewhere in the body, a real inflammatory process as expressed in the blood picture if we find leukocytosis with polynucleosis in the beginning of the disease; also the sedimentation time is often found to be more rapid. There is always an effusion of the joints in the beginning. This might be of the exudative type, when the effusion will last for quite a time; or it may be of the fibrous type, in which the effusion disappears in a short time.

2. The hypertrophic type, or arthrosis, shows marked deformity of the contours of the bone. Spur formation, osteophytes, or parrot-beak formation, will be seen in the X-ray film, but early decalcification will not be observed. The hypertrophic arthritic patient may show metabolic disturbances, symptoms of general endocrine imbalance, and, often enough, he gives evidence of constant mechanical trauma. The result of strain and stress of life appears in some persons in this form of arthritis.

In his report the roentgen diagnostician should never fail to pronounce an arthritic patient as hypertrophic or atrophic. When the hands are affected, the differentiation can be made easily and early. It is possible that both kinds of arthritis may be seen roentgenologically in a single patient, which makes the treatment and clinical management more complicated. That roentgentherapy can be of value in treating this disease is not so generally accepted.

The treatment of arthritis with X-rays dates back to Sokolow (2) in 1897. As early as 1898, Stenbeck (3) reported 52 cases of chronic arthritis of which 80 per cent could be improved by X-ray therapy. The first report in this country was made by Anders, Daland, and Pfahler, in 1906 (2). Clinically and roentgenologically their patients showed great improvement after the X-ray treatment.

Edsall and Pemberton (4) reported one case of arthritis treated by X-rays. Their publication was a warning to roentgenologists, for the toxic reaction after X-ray was, in their opinion, too dangerous. Pemberton (5) repeated his warning. Every roentgenologist who tried X-radiation in arthritis observed the same phenomenon, namely, increased pain starting after a few hours of exposure, with, sometimes, general malaise symptoms, seemingly of toxic origin (as described by Edsall and Pemberton), lasting for from one day to two weeks. The explanation given by the internist or roentgenologist (sudden tissue breakdown, with inability of the organism to take care of this invasion of dead tissues in the blood stream) did not satisfy everyone. In spite of the results observed after this reaction of increased pain had passed, the treatment of arthritis with X-rays was abandoned. Reports appeared sporadically in the roentgen literature praising the analgesic effect of X-ray treatment in arthritis. This phenomenon was explained as a direct effect on the lymphocytes and leukocytes which had invaded the nerves and were broken down through X-ray therapy, thereby reducing the tension in the nerve sheath. Undoubtedly X-rays affect the lymphocytes and leukocytes in an inflamed area, but this breaking down of blood tissues does not satisfactorily explain all the effects of radiation.

In 1921 I started to study the effect of roentgen and radium rays on nerve tissues. The general opinion at that time was that nerve tissues are highly roentgen-ray resistant, which is true so far as motor and sensory nerves and brain tissue are concerned. A few writers had expressed the opinion that X-rays or radium might have a positive effect on the vegetative nervous system, but only theories were offered. My animal experiments (6) brought me to the following conclusions: X-rays or radium affect the vegetative nervous system, first with a stimulation (Stage 1) lasting for from several

verticulum. Recently Morrison and Feldman⁴ reported a case of carcinoma occurring in a duodenal diverticulum.

Twenty-four-hour stasis in the ileum must be regarded as a pathologic condition. Heed must be given Case's warning that the 9-hour film may show an empty ileum, while the 24-hour observation may reveal barium in the terminal ileum because of regurgitation from the cecum. Of course, it is obvious that barium may be present in the ileum 24 hours after a barium meal in cases of pyloric obstructive lesions. Operative confirmation was obtained in 20 of the patients: definite obstructive disease was disclosed in all of them.

In cancer of the small intestine, the dilated atypical loop is usually irregular in contour and is surmounted by a small gas bubble. The test for occult blood is positive in nearly every case of small intestinal malignancy. The diverticulum of the small intestine is usually of smooth contour and is rarely surmounted by a gas bubble.

There are four sources of error in the interpretation of small intestinal patterns,

and I would emphasize a few guiding precepts.

(1) Never examine a patient in an attack of abdominal pain.

(2) Never examine a patient after a purgative.

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(4) Finally, never make the mistake of looking for complete obstruction. You will often find this about the terminal ileum, but those films which are truly important are the ones taken from the second to the sixth or eighth hour after the barium meal.

CONCLUSION

Intensive study of the course of the barium meal in its passage through the small intestine is necessary in order to establish the diagnosis of pathologic conditions. Careful palpation may disclose the presence of a small movable tumor that will lead to the diagnosis of a lesion in the small intestine. Routine examination of the feces for occult blood is of extreme importance in the detection of malignant ulcerative growths in the small intestine.

⁴Morrison, T. H., and Feldman, M.: *Ann. Clin. Med.*, October, 1926, V, 326.

ROENTGENTHERAPY IN ARTHRITIS¹

NEW ASPECTS AND TECHNIC

By HEINZ LANGER, M.D.

From the Deep X-ray and Physiotherapeutic Department, Western Pennsylvania Hospital
PITTSBURGH, PENNSYLVANIA

MAY I take it for granted that everyone interested in the treatment of arthritis, and its etiology and pathology, has familiarized himself with Dr. Pemberton's excellent book, "Arthritis and Rheumatoid Conditions" (1)? The classification of the numerous types of this ailment demonstrates how little we are informed about one of the oldest and most common diseases in the world. Aside from

arthritis produced by well known infections, such as tuberculosis, syphilis, and gonorrhea, as well as arthritis urica (gout), we have to distinguish two major groups of chronic arthritis.

1. The atrophic type of arthritis, called in England "rheumatoid" arthritis, shows at first only inflammatory reaction of the bones in the region of the joints, with very little osteoporosis present. In the later stage, decalcification will be observed, disappearance of cartilage followed by narrowing of the

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influences as one of the factors in the production of this form of arthritis. I have not covered all the symptoms of vegetative disturbances in arthritis, but I should like, in summing up, to mention the fact that, generally, the arthritic belongs to the nervous type, with numerous stigmata of vegetative nervous disturbance present.

Magnus-Alsleben (18) found in animal experiments that not only the arteriole but even the capillaries of the muscle are under the direct influence of the sympathetic system. He found that resection of the sympathetic nerves changes the permeability and metabolism of the tissues involved, not through change of blood supply, but through direct influence upon the sympathetic nerves. Hajos (19), Heinrich (21), and others found, in animals sensitized with horse serum, that the anaphylactic shock could be prevented if they received X-ray treatment before they were re-injected. Sometimes the anaphylactic shock appeared after re-injection, but it was retarded or in milder form.

I am fully aware of the fact that even very carefully prepared animal experiments cannot give us full information about biological questions; we are still dealing too much with theories. But, if working theories and animal experiments are correlated, we should be encouraged to go on with further study.

The above-mentioned results of animal experiments and clinical observations indicate certain influence of the vegetative nervous system in arthritis. When the symptoms appeared symmetrically, it was assumed that part of the higher situated vegetative nervous center was involved and X-rays were applied over this part of the body.

THERAPY

The first aim of the physician in charge of an arthritic patient is, of course, the elimination of the focal infection. Without going into detail, it might be said that there

has been too much removal of teeth and tonsils and not enough attention has been paid to the intestinal tract, genital organs, and lungs. We found, in a surprisingly great number of cases, erosion of the cervix with endocervicitis as the cause in women, and, in men, chronic prostatitis. Endocrine disturbances were frequently found. If a body is in a stage of allergy, a special diet might be of great value as Rowe (22) and others have proved.

Our department has had the opportunity in the last five years to treat 1,146 patients. In 783 of these cases the referring physician prescribed treatment with some kind of physiotherapy. We regret that we were unable to do anything more with this group of patients than to carry out the doctors' orders. Another group of patients received roentgentherapy in addition, with the closest co-operation of the referring physician. This close co-operation is necessary for the reaction after X-ray therapy (Stage 1).

If the vegetative nervous system of an arthritic patient (psyche and body) seems to be in a stage of hyperexcitability and X-rays are applied to some part of the body, it is possible to assume that the vegetative nervous system of the body might pass, by reflex action, through Stage 1. Increased pain will be observed. As in foreign protein shock, the general malaise which might be present can be thus partly explained. Müller and Petersen's (24) experiments demonstrate the close connection between skin stimulation and the influence on the vegetative innervation of the other organs. Since mon-arthritis gonorrhoeica can be so favorably influenced by X-ray therapy that some writers call it the treatment of choice, it is reasonable to assume that, provided the local infection is at the same time well taken care of, hypertrophic and atrophic arthritis could be influenced with roentgen rays.

Out of 363 patients who received X-ray treatment, 86 showed marked symptoms of

hours to a week or, rarely, two weeks, which passes finally to a paralyzing or quieting effect of the treated nerve (Stage 2). The effect can be observed much more easily as the nerve is in a condition of hyperactivity. This observation has been proved to be correct by Zimmern and Chailley-Bert, Gabriel (10), Lazarus and Dunbar (11), Redfield, Forbes (12), and others.

Are there symptoms of vegetative nervous disturbances present in arthritis? To answer this question let us see what is our conception of arthritis. The general opinion to-day is that the first factor to produce an arthritic condition is a bacterial infection. Whether this infection remains local or spreads more or less over different parts of the body most probably is not of such great importance. The second factor is the individual reaction of the body toward the infection. This reaction is explained to-day by most authorities as an anaphylactic reaction.² The clinical manifestations, with their typical X-ray findings, are variable and are based upon an inherited or acquired condition of the body. The vegetative nervous system seems to play a very important rôle in any anaphylactic reaction, most probably under the influence of a biochemical effect.

Pemberton has directed a great deal of research to the question of circulatory changes in arthritis. The system seems to be in a state of over-irritation, produced by the anaphylactic reaction. It can be readily understood that vasoconstriction interferes with a good blood supply to the surrounding muscles and tendons, and to joints with poor blood supply. That spastic contraction of the peripheral arteries commonly gives rise to pain is generally conceded. The presence of pain, even when the patient is in perfect rest, might be partly due to the spastic contraction of the blood vessels in the diseased

area of the body. We also have studied our arthritic patients from the standpoint of skin temperature taken by readings. Lowered temperature of the affected area was usually observed, which confirms the findings of Adson and Rowntree (13), Hensch (14), and others.

APPEARANCE OF THE SKIN

We know that the appearance of a shiny, glossy skin, sometimes in combination with edema of the underlying tissues, is explained as due to trophic changes and, as such, is identified with disturbances of the vegetative nervous system. Very often the nails show trophic disturbances, their symmetrical appearance pointing strongly toward the vegetative nervous influence. These clinical signs, sometimes combined with a symmetrical appearance of dermatitis, mostly on the lower extremities, have been frequently found in our arthritic patients.

INTERNAL SECRETION

Menge (15) found arthritis in women of the climacteric age to be practically always bilateral. Riebold (16) presents a whole group of arthritic patients with endocrine disturbances and points to the sclerodermatic changes of the skin, vasomotor disturbances, and erythema resembling urticaria. Heidenhain (17) speaks of senile, symmetrical, bilateral arthritis. In describing the hypertrophic type of arthritis in its roentgenologic aspect Pemberton says: "Although the patient may not be aware that both knees are affected, the X-ray picture will usually show bilateral involvement of bony tissue, even though one knee is without pain and seems to have normal function." He does not say it, but a certain symmetrical involvement of the bony tissues, it seems to me, can be frequently observed. This is a sign which points to the influence of the vegetative nervous system. The existence of Charcot's joints illustrates the operation of nervous

²We understand under allergy (v. Pirquet, 1906) the changed reaction of the body produced through infection, bacterial products, or other foreign body substances. It is an antigen-antibody reaction. Anaphylaxis is nothing more than a special case of allergy, as is idiosyncrasy.

two weeks after treatment, 28 per cent showed increased pain with general malaise. Opiates were needed in some cases on the first night.

Treatment can be repeated if the patient shows recurrent symptoms of vegetative nervous system disturbances. The skin temperature, taken at various intervals, can be used to determine if another X-ray treatment should be given. Increasing pain is also an indication for a repeated treatment, but at least six weeks should elapse after each X-ray series.

The reason for giving roentgen treatment in arthritis can be summarized as follows:

1. X-rays have some effect on the vegetative nervous system. After symptoms of irritation (Stage 1), a quieter condition, varying in duration (Stage 2), may be observed.
2. Roentgen rays seem to lessen anaphylactic reaction.
3. X-rays have a direct effect on lymphocytes and leukocytes and reduce general inflammation and pressure on nerve sheaths.
4. X-rays have an analgesic effect.
5. X-ray treatment produces a better blood supply in the diseased area, through its effect on the vegetative nervous system; consequently, a better tissue metabolism is established.

If the vegetative nervous system plays a certain rôle in the production of arthritis and if, as we contend, roentgentherapy has some influence on the vegetative nervous system, it is obvious that the results from such treatment cannot be expected immediately. Regeneration of tissues and their metabolism will be slow. I have frequently observed amelioration in patients even after from six to eight months have passed since treatment. These particular observations were made on patients who did not receive further treatment of any kind.

Adson and Rowntree (13), from the Mayo Clinic, have reported operative pro-



Fig. 2. For the upper extremities, one field over each side of the neck, including the centrum of the vegetative nervous system.

cedure on the corresponding ganglia and nerves in selected arthritic patients. I should like to suggest trying X-ray therapy first, because I am convinced that a great number of patients can be made comfortable without such drastic measures as these writers have used.

SUMMARY

The two most important groups of arthritis are briefly outlined.

The first publication of the use of X-ray therapy in arthritis is cited.

An attempt is made to show that the vegetative nervous system plays a certain rôle in arthritis.

The effect of X-rays on the vegetative nervous system in arthritic patients is postulated as present in two stages: Stage 1, ex-

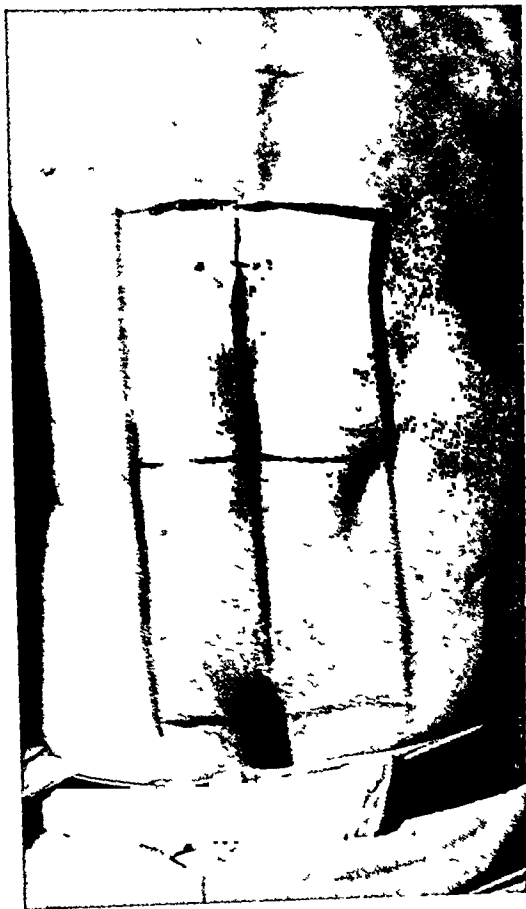


Fig 1 For the lower extremities, two or four fields, 8×18 cm, aiming at the corresponding ganglia of the lower back

vegetative nerve disturbances as described above. We gave 23 of these both local and paravertebral treatment, the remaining 63 received X-ray treatment only over the corresponding ganglia and nerves. This made them so comfortable that local treatment over the afflicted joint did not seem advisable. The coldness and clamminess of extremities, swelling of joints, and other symptoms, became less marked, and pain was greatly diminished. Only 25 per cent responded with slight improvement for a short period. The beneficial effect of such treatment lasts sometimes for quite a time. Often the treatment had to be repeated after from six to eight weeks.

Physiotherapy, internal medication, and removal of focal infection were carried out simultaneously. The beneficial effect upon patients receiving X-ray treatment compared with the greater number who received all kinds of therapy *except* X-rays, convinces us of the superior effect of the roentgen ray over other therapeutic agents.

The technic used was short wave therapy, from 185 K V to 200 K V, 0.5 mm copper, 3 mm aluminum, 35 cm skin distance, wave length 0.16 Å U, 4 milliamperes. For the lower extremities, we used two or four fields, 8×18 cm, aiming at the corresponding ganglia of the lower back (Fig 1). The inclination of the tube should be 45 degrees. Each day 200 r are given each field until from 500 to 600 r have been given. For the upper extremities, one field over each side of the neck is given, including the centrum of the vegetative nervous system (Fig 2). Each field is given 200 r daily until 500 r have been reached.

The treatment of ganglia situated higher is not always sufficient to bring about the desired result. I believe that the local treatment over the joints should be given in all cases. It is, at the present time, impossible to say whether the atrophic or the hypertrophic type shows more disturbance of the vegetative nervous system.

Out of the 363 patients treated, 65 were atrophic (18 males and 47 females); 138 were hypertrophic (45 males and 93 females). We diagnosed 160 cases roentgenologically as arthritis, either without specification of type or as belonging to the mixed type. Local treatment over the afflicted joints was given to 300 patients. For the local treatment an attempt should be made to treat the joint homogeneously with 500 r, using the same technic as mentioned previously.

After X-ray application, about 75 per cent showed increased pain lasting generally for 48 hours. For a period of from one to

disease or in treating disease an impracticable procedure. We perhaps had better step out of that rôle and give attention to this subject. It is the ignoring of such phases of medicine that has stimulated all forms of irregular medicine.

I am quite sure that, to the surgeon and internist and various specialists, the idea of applying roentgen rays to the vegetative system, or even directly to the joints, for the treatment of chronic osteo-arthritis will surely seem visionary, but we have made great progress in recent years and Dr. Langer deserves credit for his persisting attention to the treatment of the vegetative system in various affections.

He is not alone. In my early years (referred to in an article which Dr. Anders, Dr. Daland, and I presented before the Pennsylvania State Medical Society, perhaps in 1906) I treated a case of osteo-arthritis that was resisting every form of treatment of which we knew at that time, and the patient experienced relief. At the present time we do not know just why, but we have a much better idea.

In the first place, we know from many experiments and from many observations on other clinical conditions that we do get a very definite result in the treatment of various kinds of inflammations, both acute and chronic. We know to-day that one of the best forms of treatment of erysipelas is roentgen-therapy properly given, and there is nothing more acute than erysipelas as an infection.

We also know that there are many chronic infections that yield to irradiation. Matsuki, working in the Roentgen Institute under Professor Holzknicht, showed that roentgen rays applied directly to a fresh wound will aid in the healing process and give a better scar and better results.

He also performed most careful experimental work on fractures in rabbits in which he broke the bones of the legs on both sides and treated one side by irradiation immediately and left the other side untreated. He showed that he got better union, with less callus formation but more solid, as a result of a single application of the roentgen rays.

Matsuki and others have also done a great

deal of work to determine why we get results from treatment of inflammatory processes, studied experimentally, macroscopically, and microscopically. Therefore, we have a definite reason for applying irradiation locally to the joints as recommended by Dr. Langer and as a number of us have done. With regard to the vegetative system, it has been observed, for example, that lichen planus will yield to irradiation of the ganglia controlling the particular part affected, and we know that lichen planus is a chronic and very resistant form of skin disease.

Likewise it has been observed that treatment over the ganglia or over the suprarenal glands will have a beneficial effect in endarteritis obliterans or in erythromelalgia. Therefore, in the treatment of this condition, we are not going so far astray when we apply the rays over the affected ganglia.

Dr. Langer has referred to the fact that Dr. Pemberton, of Philadelphia, has shown that the circulatory changes occurring about an affected joint have a considerable influence on that joint. Now as if we reason back to these purely circulatory effects, when we are dealing with endarteritis obliterans, or erythromelalgia, or those vasomotor changes in which ulcers have been healed as a result of treatment purely on these centers, it is conceivable that treatment over the ganglia may affect the circulatory condition about these joints. It is, therefore, not so far afield, and it is not an isolated or wild observation.

If we work carefully and neglect nothing else in our treatment, we have added another instrument to our therapeutic armamentarium.

DR. E. A. MAY (Newark, N. J.): We can obtain striking results in the treatment of arthritis, especially in the more acute conditions. Consider a case of gonorrheal arthritis with great swelling, tremendous pain, and temperature: give that patient an X-ray treatment over the joint. The pain will have lessened within an hour or two, and within one or two days the swelling will have subsided. Acute infectious arthritis sometimes responds so well as to make surgical procedure unnecessary.

Chronic arthritis also responds well—of

acerbation of symptoms; Stage 2, after a certain uncomfortable period, the quiescent stage with amelioration of pain.

Cases which show symmetrical arthritic disturbances, which were treated over the corresponding ganglia and nerves in addition to the direct treatment over the afflicted joints, are described.

A statistical report, with technical comment, is furnished.

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DISCUSSION

DR. GEORGE E. PFAHLER (Philadelphia, Pa.): Osteo-arthritis is a highly chronic, obstinate, and difficult disease to treat, and in that sense it is very much like cancer. We must not merely depend upon the methods described by Dr. Langer for its treatment. It is our duty to step out of this field of specialism and be physicians and to see that the patient gets all forms of treatment that offer hope of relief. That is what the patient comes to us for; that is what the patient goes to any physician for—to get well.

When we take part in the healing process, we must co-operate with the family, or referring, physician in every way and give all the possible suggestions that will aid in curing the patient.

I think that most of us consider using the vegetative system as a factor in influencing

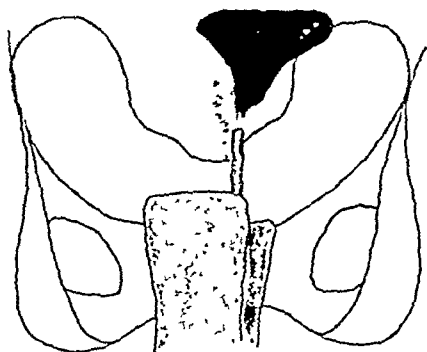


Fig. 2-A. Diagram



Fig. 2-B The same case, showing the uterus normal, holding 8 c c of oil

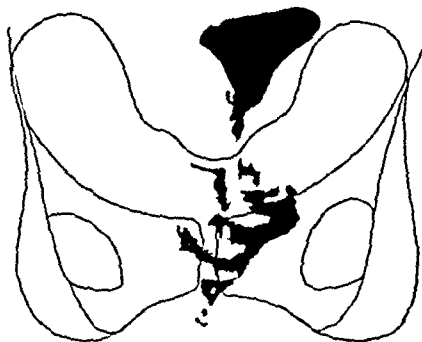


Fig 3-A Diagram.



Fig 3-B. The uterus is allowed to empty and the oil can be seen dripping through the cervix into the vaginal vault

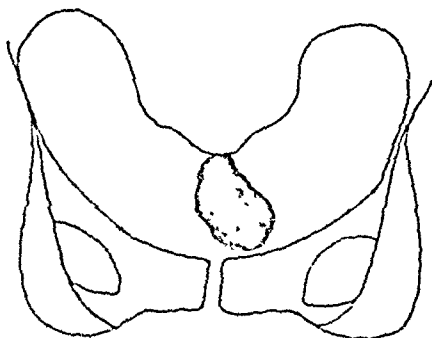


Fig 4-A Diagram



Fig 4-B The same case. The uterus is entirely empty. The oil is visible on a pad in the vagina

course not so quickly as in the acute case, but it is very gratifying to note that patients do not complain of pain, and, in cases in which the knee is affected, to see them walking again.

We combine X-rays with diathermy, which has a very good effect. I do not think I give as much radiation as Dr. Langer does, if I understand him correctly. The more acute the case is, the less radiation I give, 15 or 20 per cent of an erythema dose. In more chronic cases I give more, repeating the dose when necessary—every week or two weeks. After the series is finished, I wait four weeks before resuming treatments.

DR. LANGER (closing): It is very difficult to come before any Society, offering a new

point of view and technic. One is always received with a certain skepticism. It is a new field, but I was glad to hear, at the International meeting in Paris, that our French confrères were interested in it. They have worked empirically for some time on that same problem. Zimmern, Cottenot, Desplats, Gouin, and others belong to this group.

We are going on with this kind of technic and we hope (and that is the reason I brought this paper before you) to get co-operation from others. Try it in some cases, please, which do not make progress under other therapeutic procedures. I am sure you will find that this new technic will give you satisfaction in selected cases.

ROENTGEN-RAY EXPLORATION (DIAGNOSIS) OF PELVIC VISCERA WITH AID OF IODIZED OIL¹

By JOSEPH JOHNS EISENBERG, M.D., MILWAUKEE, WISCONSIN

SINCE 1927, we have been using iodized oil as an aid in visualizing the uterine cavity and fallopian tubes. Up to 1928, we used lipiodol and iodipin, but for the last three years we have applied brom-

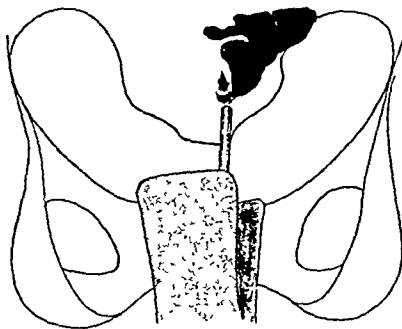


Fig. 1-A. Diagram

inol, a 37 per cent solution of bromine in olive oil. Primarily, injection was undertaken solely to visualize the physiologic action of the tubes. That the physiologic function of the tubes is a necessary factor in the



Fig. 1-B. A normal uterus holds from 3 to 5 c.c. of oil. The uterus shown here has been injected with 5 c.c. of oil, but is not entirely filled, evidencing a defect in the left body of the uterus. The roentgenogram should show the uterus entirely filled.

transportation of the ovum has been assumed by physiologists. As far as is known, the functions of the tubes or their actions have never been observed during laparotomy, perhaps due to the general anesthesia which causes paralysis of the muscles of the tubes.

In 1922, Sicard and Forestier (6)

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

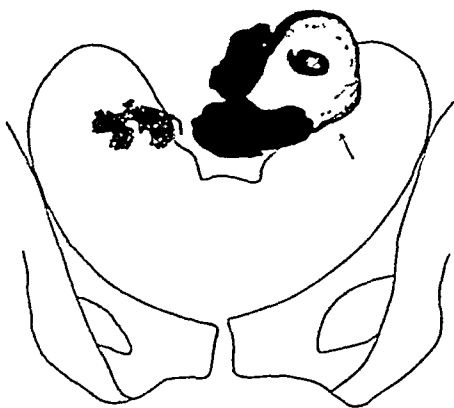


Fig. 8-A. Diagram.

brought forth the use of lipiodol as a contrast medium. Corner and Seckinger (1), in 1923, were able to prove peristalsis of the tubes in animals by registering on films the movements of the tubes in monkeys and hogs. Dyroff (2), in 1925, succeeded in demonstrating peristaltic movements in the human with X-rays. Kok (3) has carried out numerous experiments on living animals in order to study the physiology of the muscles of the fallopian tubes. He summarizes the results of his work as follows:

1. Peristalsis is the normal physiologic movement of the fallopian tubes.
2. Peristalsis is directed from the fimbria to the uterus.
3. The presence of a foreign body in the ampulla produces antiperistalsis.

Rubin (5), in 1926, described tubal peristalsis in women.

At the beginning of our work, all injections of iodized oil into the uterine cavity were observed and studied under the fluoroscopic screen. X-ray plates were then taken after from five to fifteen minutes. These were re-checked by films made within one-half hour, one hour, three hours, and twenty-four hours. Necessary cases were roentgenographed and studied at various intervals for varying periods, some as long as seven months (Figs. 1-A through 8-B). By careful observation, in introducing the iodized oil into the uterine cavity, and



Fig. 8-B. The same case, which was followed for seven months. The diagnosis is right utero-ovarian cyst. This illustration shows the necessity of following cases injected with iodized oil for diagnostic purposes.

fluoroscopically watching it as it enters the tubes, one sees the peristalsis and contractions in from five to fifteen minutes.

A series of cases was studied fluoroscopically and then roentgenographed for observation of the physiologic function. At first, it was difficult to determine whether or not peristalsis was present. With increased experience, a strong contraction of the isthmic portion (Figs. 9-A and 9-B) and a rhythmic contraction of the ampulla were visualized (Figs. 10-A and 10-B). The ampullar contractions, at times, became worm-like and tortuous (Figs. 11-A through 13-B), due to antiperistalsis as a result of the foreign body injected. In but few cases could one observe a normal physiologic function, namely, a true peristalsis, from the fimbria toward the uterus (Figs. 14-A through 16-B). The most common sites in which stenosis was observed, due either to adhesions or sealing of the tubes, were at the isthmus and fimbriated ends (Figs. 17-A through 18-B). The first part of the tube corresponding to the isthmus was, as a rule, thin, extending downward, and was usually from 1 to 2.5 inches in length (Figs. 19-A and 19-B). The contractions at this part were usually the strongest. The part corresponding to the ampulla extended downward



Fig. 5-B. The same case. The uterus has been injected with 10 c.c. of oil, showing both uterine sphincters. The left isthmus is plainly visible, with the ampulla, which is beginning to widen, containing pearls of oil.

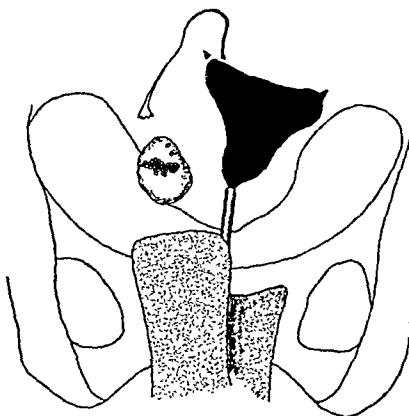


Fig. 5-A. Diagram.



Fig. 6-B. The same case. The uterus and adnexa have been injected with 20 c.c. of oil, which demonstrates a clumped left tube and a large hydrosalpinx encroaching on the right cervico-uterine body. The mass is also behind the posterior uterine body.

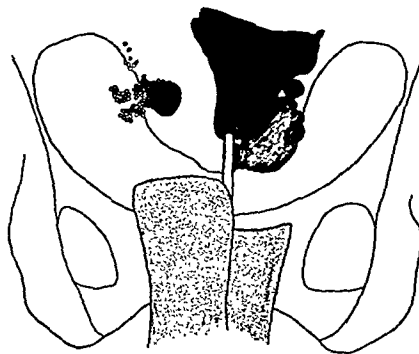


Fig. 6-A. Diagram.

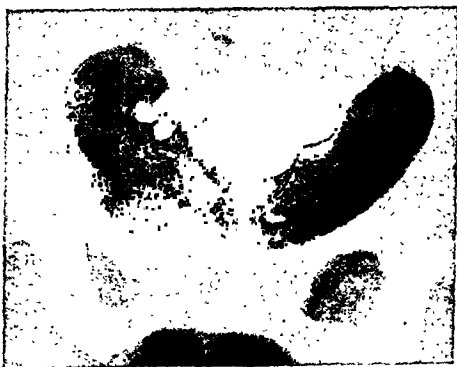


Fig. 7-B. The same case. The uterus is empty 24 hours after the injection, and the vagina shows no traces. Note the huge hydrosalpinx.

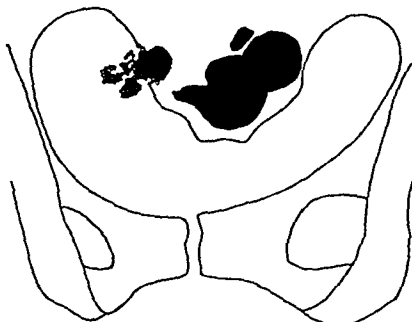


Fig. 7-A. Diagram.

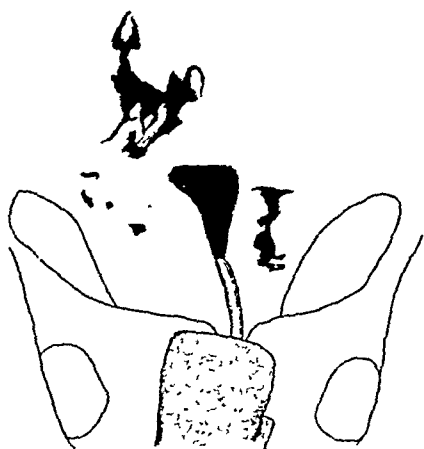


Fig. 12-A. Diagram.

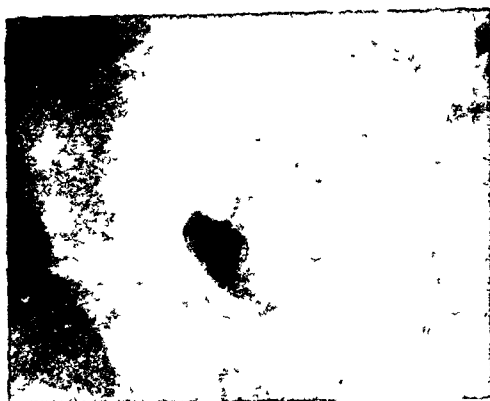


Fig. 12-B. A tortuous left tube, extending high into the abdomen. The right tube is prolapsed into the pelvis.



Fig. 13-A. Diagram.



Fig. 13-B. An illustration of the shape and position the normal tubes may assume. Note the spill of both fimbriae

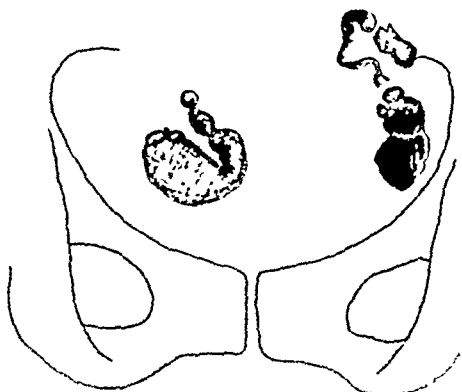


Fig. 14-A. Diagram



Fig. 14-B. True peristalsis from the fimbria toward the uterus. This is best seen under the fluoroscopic screen by emptying the uterus of oil after the tubes are filled

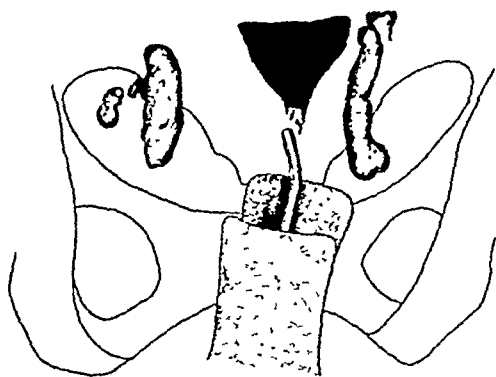


Fig. 18-A. Diagram.



Fig. 18-B. Showing the site of constriction at the fimbria, with sacculated tubes.

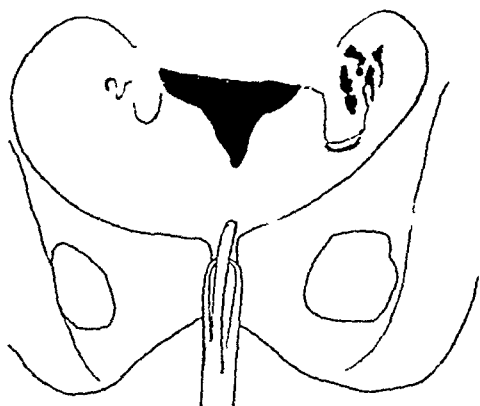


Fig. 19-A. Diagram.



Fig. 19-B. Note the outlines of both isthmuses. They are thin, from 15 to 25 inches long, usually extending downward.

and outward and was nearly always the most widened portion (Figs. 20-A and 20-B). Motion in the ampulla could almost always be seen; it at times assumed a good many different positions. The fimbria appeared fan-shaped, encircling the surface corresponding to the ovary (Figs. 21-A through 22-B).

The consistency and size of the uterus, with or without tumor masses, can, as a rule, be determined by the usual bimanual examination; however, a considerable number of growths may escape detection. One cannot always determine a growth by palpation, whether it is part of the uterus or a tumor mass of the adnexa. Upon the X-ray plate, a filling defect within the uterus is

usually found to be due to uterine myomas (Figs 23-A and 23-B). Irregular outlines of the uterine cavity are, as a rule, due to extra-uterine tumors (Figs. 24-A and 24-B) which produce pressure upon the uterine wall. In markedly obese patients, the outline of the uterus can be plainly seen on the X-ray plate with the aid of iodized oil, though bimanual examination does not reveal whether the mass so palpated is a part of the uterus, tube, or ovary (Figs. 22-A, 22-B, and 25-A through 27-B).

Stein (7) stated that fibroid tumors cannot be diagnosed by X-rays with the use of only iodized oil. Our study corroborates his findings. During the last three months we have been using iodized oil combined



Fig. 15-B. True peristalsis. Note the characteristic beadings. Both fimbriae encircle the ovaries.

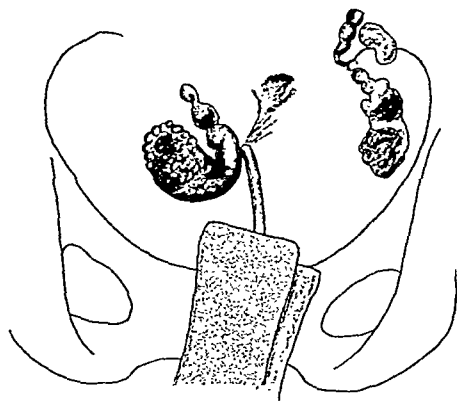


Fig. 15-A. Diagram.



Fig. 16-B. True peristalsis of both tubes with the uterus filled with oil.

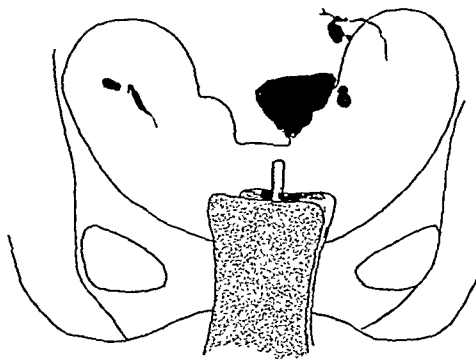


Fig. 16-A. Diagram.



Fig. 17-B. Constriction of both isthmus portions of the tubes is seen, due to adhesions.

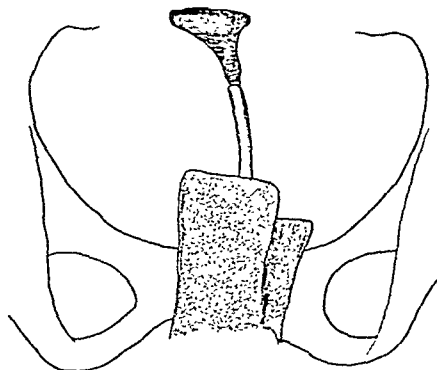


Fig. 17-A. Diagram.

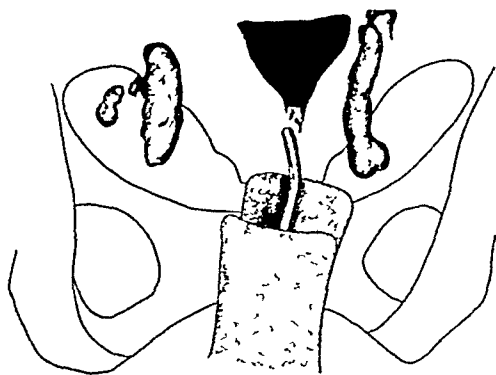


Fig. 18-A. Diagram.



Fig. 18-B Showing the site of constriction at the fimbria, with sacculated tubes

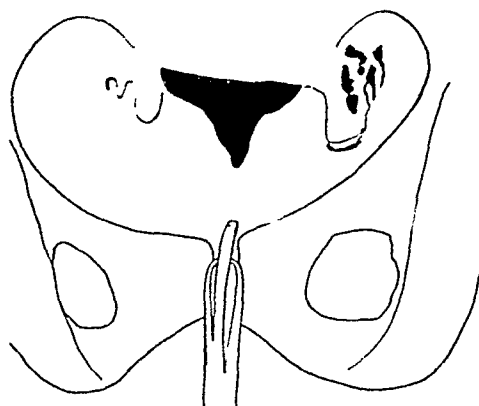


Fig. 19-A. Diagram



Fig. 19-B Note the outlines of both isthmuses. They are thin, from 15 to 25 inches long, usually extending downward.

and outward and was nearly always the most widened portion (Figs. 20-A and 20-B). Motion in the ampulla could almost always be seen; it at times assumed a good many different positions. The fimbria appeared fan-shaped, encircling the surface corresponding to the ovary (Figs. 21-A through 22-B).

The consistency and size of the uterus, with or without tumor masses, can, as a rule, be determined by the usual bimanual examination; however, a considerable number of growths may escape detection. One cannot always determine a growth by palpation, whether it is part of the uterus or a tumor mass of the adnexa. Upon the X-ray plate, a filling defect within the uterus is

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Stein (7) stated that fibroid tumors cannot be diagnosed by X-rays with the use of only iodized oil. Our study corroborates his findings. During the last three months we have been using iodized oil combined



Fig 20-B The ampulla of the tubes is usually dilated and the most widened portions, as a rule, extend downward into the pelvis

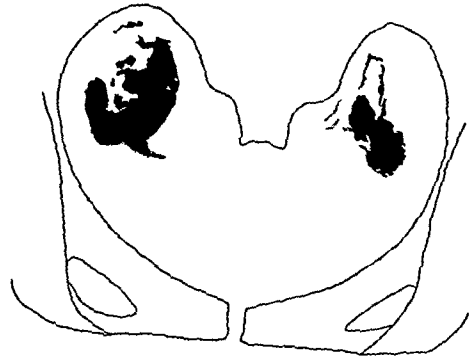


Fig 20-A Diagram



Fig 21-B Both fimbriae are plainly seen encircling the surface corresponding to the ovaries.

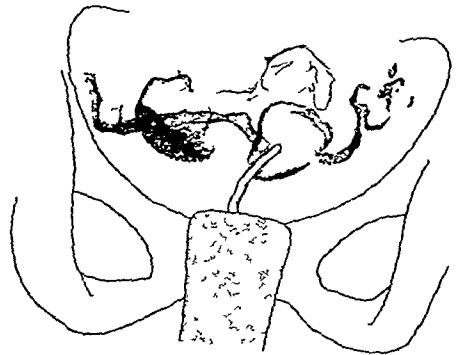


Fig 21 A Diagram



Fig 22-B The fan-shaped right fimbria, encircling the surface of the ovary

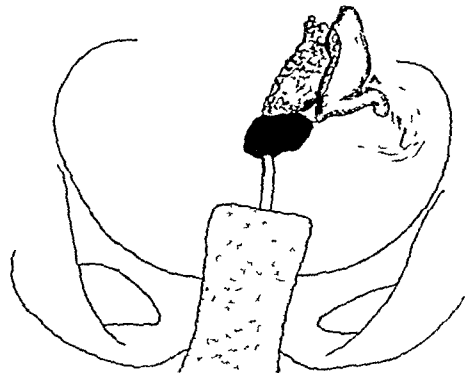


Fig 22-A Diagram

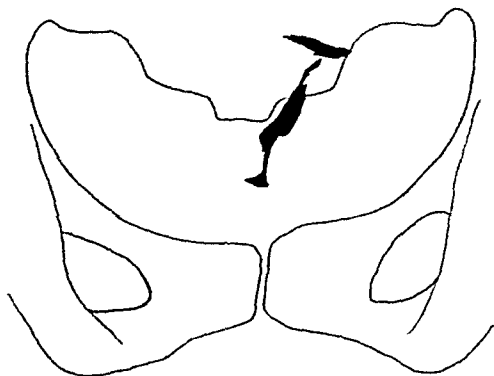


Fig. 23-A. Diagram

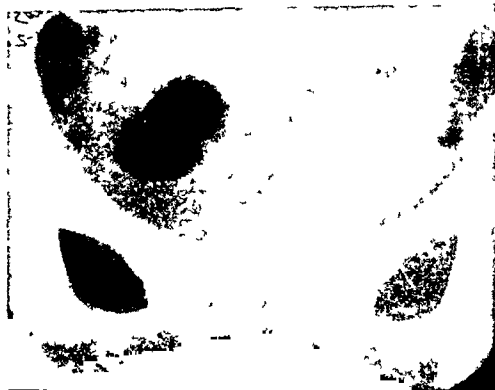


Fig 23-B The uterus has failed to fill, due to myomas

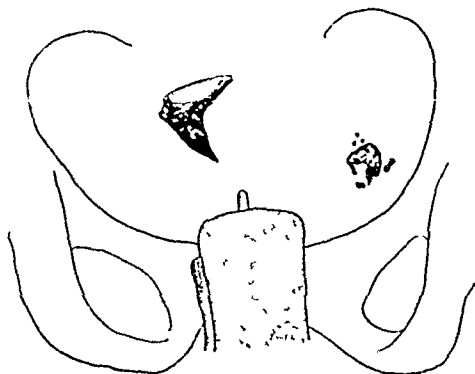


Fig 24-A Diagram.



Fig 24-B Deformity of the right cervical uterine body is present, due to a large ovarian cyst. The right tube is visible in the pelvis

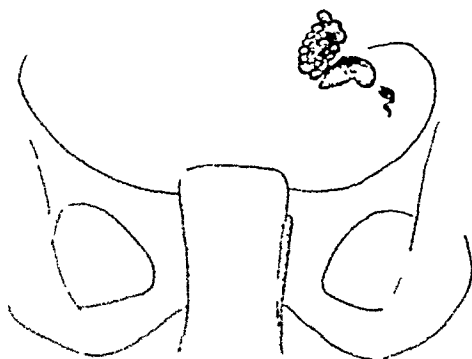


Fig 25-A Diagram.



Fig 25-B The right uterus and tube, injected with 5 cc of oil

with the method of pneumoperitoneum, which, we believe, is a more satisfactory and ideal way of localizing tumors of the uterus and adnexa. Either iodized oil or pneumoperitoneum, used separately, has its own advantages: one is indicated where the other is not and *vice versa*.

At first, especial care was taken not to use intra-uterine injections of iodized oil if any cervical discharge was present. The same rule was applied to cases in which there was any suspicion of the presence of endometritis or salpingitis. Prior to 1922, iodized oil was used orally and by injection for its therapeutic effect. Two years ago, it occurred to us that if iodized oil could be used as a diagnostic and therapeutic adjuvant in cases of bronchiectasis and tuberculosis of the lungs without any ill effects or complications, why, then, could it not be used for intra-uterine insufflation in cases of endometritis and salpingitis (non-gonorrheal)? It has, therefore, been used during the last few years, being slowly applied and carefully observed, in all cases with cervical discharges of known endometritis. Slides were examined to rule out gonorrheal infection. No ill effects were complained of nor did complications follow. As a matter of fact, in a good percentage of the cases the discharge subsided partly or almost entirely. Finally, it was introduced in cases of known salpingitis, caused either as a result of post-abortive conditions or post-deliveries. These cases were carefully watched and re-examined, and no ill effects were produced in any.

Iodized oil has never been used by us in establishing a diagnosis of pregnancy or in cases of known carcinoma. Miller and Martinez (4) have shown that abortion is likely to follow introduction of oil into a pregnant uterus. In cases of carcinoma, there is a possibility of distributing cancer cells.

In the cases studied we have the primarily sterile as well as patients who have previously given birth to infants and later become

sterile, due either to post-abortions or adhesions of the tubes following delivery. Others have become sterile, probably due to an attack of appendicitis, either before or soon after marriage. A good many of these cases have become pregnant in from three to nine months. These are the cases in which the use of intra-uterine and tubal insufflation is of pathognomonic value. A patient with a bicornate uterus (Figs. 13-A, 13-B, and 28-A through 29-B), who had been subjected to a carbon dioxide pneumoperitoneum three years previously, was delivered 16 months after insufflation with iodized oil.

The cases were ambulatory. All injections were given in the clinic and no enemas or narcotics were necessary. The patient is put on a flat Bucky X-ray table. A weak lysol solution is used to cleanse the labia and vagina. A bivalve speculum is inserted, after which the cervix is painted with mercurochrome. A single tenaculum holds the cervix and a cannula is inserted into the cervical canal. Dilatation of the cervix is not necessary. A couple of small, moist pieces of gauze are inserted about and around the cervix. The syringe is attached to the cannula, the palm of the hand which holds the syringe being the best manometer. Usually, at first 5 c.c. are injected, more if necessary. We have never used more than 20 c.c. of iodized oil.

In 100 private cases studied for a period of four years, in which iodized oil was used, there have been no ill effects or complications produced. Included in these are a good number which were operated upon. Among them are a number of cases of known endometritis and hydrosalpingitis injected for diagnostic and therapeutic purposes. In endometritis with symptoms of discharge, slides were made to rule out active gonorrhea. All cases of known endometritis and salpingitis, after being injected with the iodized oil, evidenced an increased amount

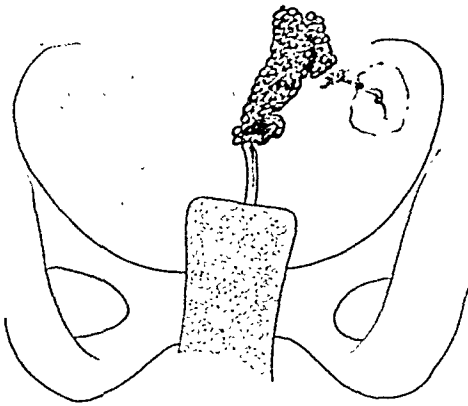


Fig. 26-A. Diagram.

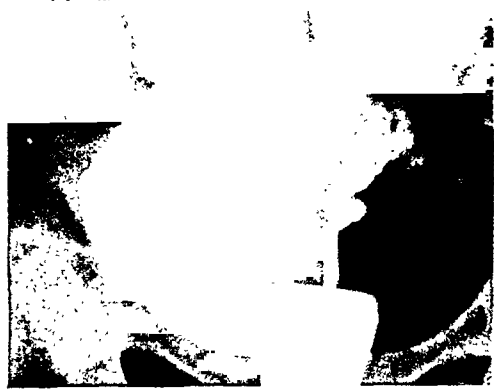


Fig. 26-B. The uterus, filled with 12 c.c. of oil, showing the right and left tubes behind the posterior wall of the uterus.

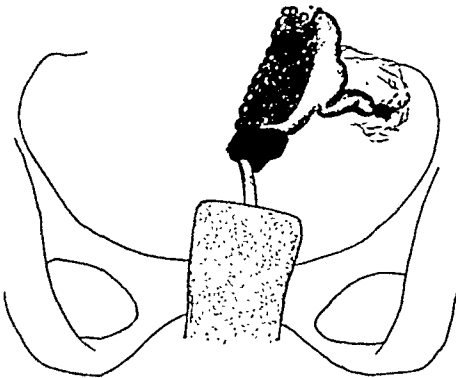


Fig. 27-A. Diagram.

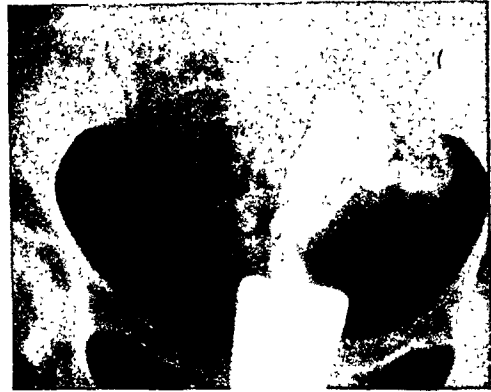


Fig. 27-B. The uterus and tubes filled with 20 c.c. of oil, showing plainly the outline of the uterus. Both tubes are adherent to and behind the uterus.

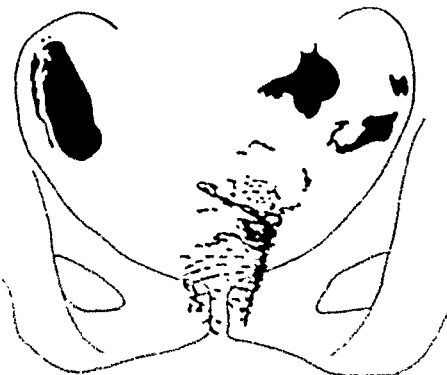


Fig. 28-A. Diagram.



Fig. 28-B. The right cornu filled with oil. The right tube shows a spill. The left tube is sacculated, with a visible spill of fimbriae.



Fig. 29-B. Both uterine cornua are filled with oil, plainly showing the bicornate uterus

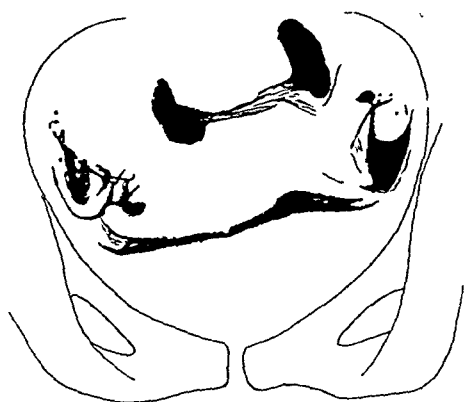


Fig. 29-A. Diagram.

of discharge, followed by a gradual decrease, and almost entire subsidence in from two to three months. A normal menstrual cycle was restored in many.

X-ray interpretation should be made by a competent radiologist. Cases injected with iodized oil should be studied for at least two or three months with X-ray plates. Many times abnormal findings, which are not visible at first, may be detected at a later period (Figs. 1-A through 8-B).

There should be more co-operation between the gynecologist and radiologist. The clinical findings in borderline cases should be corroborated by X-ray interpretation.

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DISCUSSION

DR. L. R. SANTE (St. Louis, Mo.): We have used iodized oil in pelvic radiography, especially in conjunction with pneumoperitoneum. Having first secured proper inflation, you produce pneumoperitoneum which can be followed by the injection of iodized oil. By the use of both methods, you can secure even further information than by either method alone.

We have endeavored to use iodized oil injections in determining the condition of the uterus, for instance, in certain therapy cases, and have found it of great value. Efforts to outline the extent of carcinomatous involvement have not been so successful.

Every once in a while a patient is sent for treatment, perhaps of a supposed submucous fibroid, on account of bleeding. We treat the patient, but without a satisfactory result. We are not able to tell just exactly what is going on a little higher up. In those cases, the injection of iodized oil may remove all doubt and sometimes lead to correction of an erroneous diagnosis.

Iodized oil injection with X-ray examination should be utilized for diagnosis for all lesions of the uterus above the cervix before radiation therapy is undertaken. We have

even gone so far as to attempt to use iodized oil to indicate the contour of a carcinomatosus involved cervix, before treating the growth, but this is not such a satisfactory procedure because the very density of the oil overshadows the underlying irregularities of the cervix. The method is to place the patient on a table in a tilted position, and to plug the vagina with a rather large rubber bulb during the introduction of the oil. This, however, has not proven so satisfactory.

DR. EISENBERG (closing): We have attempted to show and prove the value of the use of iodized oil as an aid in visualizing the

uterine cavity and fallopian tubes. Besides being used roentgenologically for diagnostic procedures, iodized oil has proven itself therapeutically beneficial.

We believe that the effects of iodized oil for the period that we have used it should be concluded as entirely harmless. Iodized oil should be incorporated as an aid in radiology. Its use should be welcomed by the gynecologist, surgeon, and general practitioner.

The comments in the discussion made by Dr. Sante are well taken. We have lately combined pneumoperitoneum with iodized oil as an aid in localizing gross tumor masses, such as fibroids and cysts.

EXPERIMENTAL CLINICAL RESEARCH WORK WITH X-RAY VOLTAGES ABOVE 500,000

A PRELIMINARY STATEMENT¹

By ALBERT SOILAND, M.D., D.M.R.E., LOS ANGELES

DURING the Summer of 1930, the writer was invited by Dr. R. A. Millikan and Dr. C. C. Lauritsen, of the California Institute of Technology, to inspect the high voltage X-ray tube installation at the Institute. Dr. Lauritsen, who had been experimenting with the 1,000,000-volt transformer set at the Institute, had succeeded in building a large X-ray tube of glass through which 5 ma. of current operated successfully at 750,000 volts. This equipment, which was designed for physical research purposes only, had been in successful operation for many months. It occurred to Dr. Lauritsen that the radiation produced by this tube might have some biologic effect which could be utilized in the treatment of disease. Because the writer was much impressed by Dr. Lauritsen's achievement, he suggested, after consultations with Dr. Millikan and Dr. Lauritsen, that he be permitted to put the tube to clinical tests. After investigating further and advising with the writer's own clinical associates, Dr. Costo-

low and Dr. Meland, Dr. Millikan and Dr. Lauritsen agreed, with the consent of the Board of Trustees of the California Institute of Technology, that we be allowed to bring some of our own patients to the Institute for experimental clinical tests.

The experimental treatment schedule was begun in October, 1930. The first patient treated was a middle-aged man with an inoperable adenocarcinoma of the rectum, a patient of Dr. C. Edgerton Carter.² The electrical factors for this first experimental treatment were: voltage, 600,000; milliamperes on the tube, 4; filters, 6 mm. of steel and 1 cm. of felt; skin-target distance, 50 tuberculosis. Spondylitis with lipping, which centimeters. Those present at the dedication of the Lauritsen tube were Dr. Millikan, Dr. Lauritsen, Dr. Carter, and Dr. Soiland.

After this experimental beginning, we selected a small number of our own patients who had inoperable and hopelessly advanced

¹Presented at the Radiological Society of North America, at the Eleventh Annual Meeting at Atlantic City, Nov. 28-Dec. 1, 1932.

²As an item of interest, it may be stated that this patient today, two years after his first treatment, has gained 20 pounds in weight, has no pain, and attends to his daily labors. The proctologist who has examined him recently says there is but a residue of the oil lesion present.

carcinoma of various organs—patients who already had been under treatment and had become radiation-fast with our standard X-ray equipment. We carried on these experiments over a number of months and became convinced that the high voltage X-ray beam, as delivered by the Lauritsen tube, presented tangible effects which we had not always been able to produce with our own standard equipment.

Assisted by Dr. Lauritsen and his research associates at the Institute, we prescribed a tentative set-up of 550 K.V., filtered through 6 mm. of steel, with 4 ma. on the tube, and a 50 cm. skin-target distance. With this arrangement, 900 r will produce a pronounced skin erythema, if given in one treatment, at the rate of 20 r per minute. The result of the preliminary work was encouraging enough to warrant the establishment of a better organized unit for continued clinical research.

About this time, Mr. W. K. Kellogg, of Battle Creek, Michigan, who visited the Institute, became sufficiently interested in the work to donate funds for the building of a separate high voltage laboratory, now completed.

Dr. Lauritsen has more recently constructed a tube with a capacity of 1,000,000 volts potential, and further research work is going on in the new Kellogg Laboratory with the following factors: 750 K.V., 4 ma., 6 mm. steel and 1 mm. Al filter, 70 cm. skin-target distance. This department is under the immediate charge of Dr. Seeley G. Mudd, who has become greatly interested in the work and devotes his time and energy to the furtherance of the clinical experimentation. Dr. Mudd is assisted by Dr. Clyde K. Emery and by my clinical associates, Dr. William E. Costolow and Dr. Orville N. Meland, as collaborators.

The entire work is under the supervision of an advisory medical board of seven California clinicians, of which the writer is the radiologic member. This board rightly feels

that no evaluation of results can be made until the permanency of the effects has been established by due process of time.

Every patient submitted to treatment is carefully examined by a competent group of clinicians connected with one of the leading hospitals. Only such patients are accepted as are found to be unfit for surgery and resistant to the usual type of X-ray treatment available in the ordinary cancer clinic or general hospital.

More than two hundred patients have now been submitted to radiation, and no startling variations from the former routine are noted. Skin erythema and tanning occur in approximately the same ratio as with lower voltages, indicating that there is little or no difference in biologic skin reaction, irrespective of voltage used, once the erythema skin unit dose has been established. Whether or not this ratio holds true below the skin surface and beyond the vision is problematical. This solution may well rest until sufficient time has elapsed to establish permanently cell and tissue reactions, both latent and delayed, from radiation of every wave length or voltage. Radiation sickness also occurs; likewise, the usual systemic reactions with varying neuroses. All in all, no gross specific differences have been elicited. Clinical reactions are a little more difficult to interpret. It appears to the writer that patients who reach a point of stasis in their clinical response to X-ray treatment at 200 K.V. usually improve when they are submitted to 500 K.V. or over. Whether this is due to the higher voltages or to more homogeneous radiation with increased depth dosage, or whether there is a biologic radiation difference, the future will have to demonstrate.

Two full years have elapsed during which this therapeutic work at the California Institute of Technology has been carried on at a voltage of 550,000, and 4 ma. in the tube high line, and the other factors already quoted. At the time of this writing, treat-

ment work has been started in the new Kellogg Laboratory, with a tube voltage of 750,000, a little higher filtration, and a little longer skin-target distance. The Institute intends to prosecute steadily an analytic experimental treatment research campaign.

To the clinical radiologist, the outcome of this research work will be of momentous importance. If we recall that, for the past ten years, there has been no appreciable change in therapeutic apparatus, the best obtainable up to the present being a possible peak of 200,000 volts, to soar into a voltage four times higher presents problems which require most serious and earnest consideration. Apparatus of this extreme voltage is limited to institutions in which the best engineering skill in its construction and assembly is available, with physicists in control of operations, so that all electrical and X-ray dangers are reduced to the lowest possible minimum.

Should it develop later that this super-short wave X-ray therapy is superior to anything we have had in the past, it will be necessary for the treatment to be made more universally available. To accomplish this we must consider certain very essential factors which will be briefly touched on here.

1. The cost of equipment and accessories, which would vary from thirty to fifty thousand dollars, according to style and size of equipment, with its housing requisites. Such a formidable installation would, in the writer's opinion, be prohibitive for the average radiologist even to consider. It would be more feasible for centralized institutions, geographically selected to serve their respective communities—preferably the larger hospitals having suitable clinical and physical facilities.

2. The maintenance and operation of such an X-ray center.

It would be impossible for the average physician or radiologist to operate such an institution himself. Electrical engineers and

qualified physicists would be required to maintain the efficient operation of a super-high voltage plant with its powerful transformer and intricate control panel, its tube with connecting vacuum pumps and pressure gauges, its ionization chamber and spectrograph, and all the other requisites necessary to keep the radiologist continually informed of the exact output of the tube, in order that the required dosage might be accurately calibrated.

3. Dangers, both electrical and X-ray, to the patient and to the operator.

Naturally, every known precaution is constantly necessary in order that anyone coming into the vicinity of the X-ray tube or the high tension electrical line may be amply protected. The proper correlation and execution of these factors must be obtained so that the patient may derive the greatest benefits from these, as yet, experimental and potentially dangerous methods of treatment.

It already appears practical, both from an electrical and an engineering angle, to manufacture X-ray equipment and tubes up to an almost unlimited voltage. It behooves us, therefore, to make haste slowly and, first, to be sure of our ground with an already known voltage before we essay a flight into the unknown, for there we may reach a point beyond the safety limits of the normal cell where unlimited and irreparable damage may result.

It is now well established in all scientific circles that radiation plus surgery (or radiation alone) are the best weapons so far developed to destroy cancer cells. If, as may not be improbable, time demonstrates that the shorter wave lengths from the higher voltages such as those under discussion, bring results which are superior, it then becomes mandatory for us to carry forward this work that the service may be extended and made available throughout the medical world to all who may need it.

Before embarking on this new venture on a pretentious scale, good judgment requires

that we keep an orderly balance and observe and tabulate most accurately results from the experimental work already under way.

If we are to agree with some of the physicists who have studied radiation therapy and believe that X-rays from any and all voltages have the same biologic effect, then we must resort to still higher voltage to obtain the penetration needed for the treatment of deep-seated malignancies. Again, those of us who have the courage of our convictions, and believe that we yet have a great many things to learn about short wave radiation, must needs maintain our hopes and expectations that every new de-

parture into the fields of higher electronic energy will prove of greater benefit to an afflicted human race and eventually render more conquerable that universal, dread disease—cancer.

In closing, the writer desires to emphasize the fact that the contents of this article are merely expressions of his own opinion and belief, and not an official report from the California Institute of Technology.

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STUDIES OF THE EFFECT OF ROENTGEN RAYS ON THE HEALING OF WOUNDS

II. HISTOLOGICAL CHANGES IN SKIN WOUNDS IN RATS FOLLOWING POST-OPERATIVE IRRADIATION¹

By ERNST A. POHLE, M.D., Ph.D., Professor of Radiology, and
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IN a previous communication² we reported the results of our experiments dealing with the behavior of skin wounds in rats under pre- and post-operative irradiation. It appeared that exposure to a dose of 1,000 r given in one sitting from 1 to 30 days before the incision did not influence the healing process perceptibly. Exposure to a dose of 1,000 r in one sitting immediately, 24, and 48 hours, respectively, after the incision retarded the healing process, particularly in the 24-hour group, but did not interfere with the final formation of a smooth scar. In view of these findings it seemed advisable to investigate further the histological changes found in incisions exposed to roentgen rays. The technic used was identically the same as described in the first paper, with one fundamental exception. While in our first se-

ries histological findings were recorded only 7 days after the cutting or after complete healing of the wounds, in this second group specimens were taken at daily intervals of from 1 to 9 days after the incision. A minor change was the use of metaphen as a disinfectant. Since in the first series no difference could be detected in the reactions produced by the two wave lengths chosen, only one (100 K.V., 2.0 mm. Al λ eff. = 0.34 Å. transmitted through 2.0 mm. Al) was employed in this study. Thirty-four rats were exposed immediately, 26 rats 24 hours, and 18 rats 48 hours after cutting, making a total of 78 animals in this report.

PROTOCOLS OF EXPERIMENTS

A. Exposed Immediately after Incision (34 Rats)

Rats Nos. 75, 76, 77, 78, killed 1 day after incision.

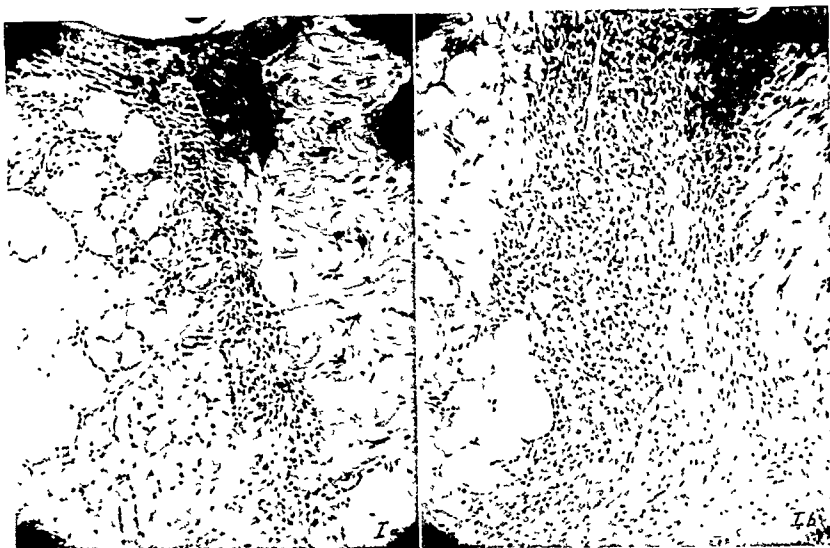
¹Received for publication April 7, 1932
²RADIOLOGY, April, 1931, XVI, 445.

Rats Nos. 71, 72, 73, 74, killed 2 days after incision.

In these two groups no difference could

there was a great difference in fibroblastic activity in favor of the control halves.

Rats Nos. 1, 2, 3, 4, 5, 6, 26, 27, 29, 30,



Figs 1-A and 1-B. Rat No. 3. Sections across wound. Irradiated immediately after cutting; section taken 7 days later. *A* (left), treated part; *B* (right), untreated part. Note great difference in amount of newly formed fibrous tissue, with a proportional difference in cellular activity along the margins of the wound.

be noted between the healing in treated and untreated parts. Almost no cellular activity was seen in the sections.

Rats Nos. 31, 32, 33, 34, 51, 52, 54, 55, killed 3 days after incision.—In Rat No. 33 there was fairly well-advanced healing in the untreated part, but inactivity in the treated part. In Rat No. 52 the control part of the wound showed almost complete healing, while the treated part lagged somewhat. A slight difference was noted in Rat No. 54, the untreated part being further advanced in healing.

Rats Nos. 25, 28, 53, 56, killed 4 days after incision.—In Rat No. 25 there appeared a marked difference between the two halves, the untreated part being considerably in advance of the treated part. This is also true of rats Nos. 53 and 56.

Rats Nos. 35, 36, 37, 38, killed 6 days after incision.—In all of these wounds

killed 7 days after incision.—These sections all showed in different degrees an advance in healing in the untreated portions.

B. Exposed 24 Hours after Incision (26 Rats)

Rats Nos. 57, 60, killed 2 days after incision.—No difference between the treated and untreated parts could be observed.

Rats Nos. 19, 22, 58, 61, killed 3 days after incision.—No marked difference could be seen in Nos. 19, 58, and 61. The wound of Rat No. 22 was infected.

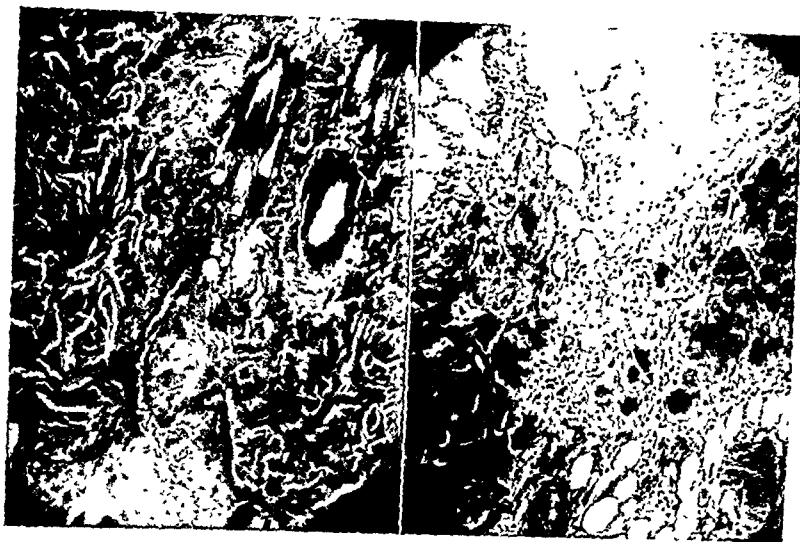
Rats Nos. 20, 23, 59, 62, killed 4 days after incision.—In Rat No. 20 no difference could be noted. In No. 23 the epithelium had healed over in both halves, but the connective tissue underneath was inactive in the treated part, practically healed in the untreated half. A slight difference in favor of

the untreated part could be seen in Rat No. 59, but none in No. 62.

Rats Nos. 21, 24, 67, 68, 69, 70, killed

No. 64, in which there was slight advance in favor of the treated part.

Rats Nos. 17, 18, 43, 44, 45, 46, killed



Figs. 2-A and 2-B. Rat No. 20. Treated 24 hours after cutting; sections taken 4 days after cutting. *A* (left), treated part; *B* (right), untreated part. Note lack of healing in *A*, in spite of better approximation, and active fibroblastic proliferation in *B*.

4 days after incision.—In all these wounds except No. 70 there was a decided difference in favor of the control parts. In No. 70 the condition was reversed (possibly a technical error).

Rats Nos. 39, 40, 41, 42, killed 7 days after incision.—The usual difference, varying in degree, prevailed in these wounds. In No. 39 the tissue was distorted, making exact evaluation difficult, but the other three were clear-cut in result.

Rats Nos. 7, 8, 9, 10, 11, 12, killed 8 days after incision.—Healing in these was more advanced in the control halves of the wounds.

C. Exposed 48 Hours after Incision

Rats Nos. 63, 64, 65, 66, killed 4 days after incision.—No difference between the two halves of the wounds here, except in

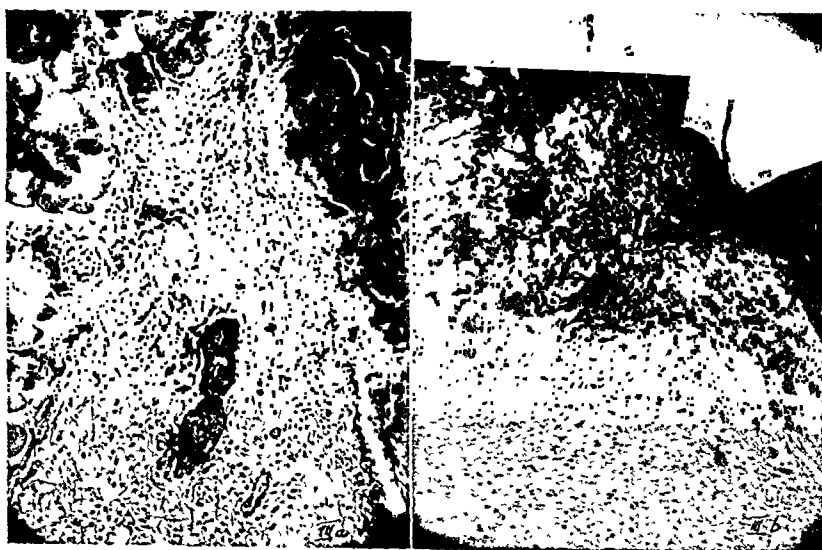
days after incision.—In rats Nos. 17 and 18, the fibroblasts appeared to grow up from the deeper parts of the wound, with little activity superficially. In the control portions, growth was straight across the wound. In the rest of these a slight difference was noted in favor of the untreated halves of the wounds.

Rats Nos. 15, 16, 47, 48, 49, 50, killed 8 days after incision.—In Rat No. 16, though there was infection, a distinct difference could be noted between the treated and untreated parts, the untreated part being further advanced in healing. In No. 48, the directional difference could be noted as in Nos. 17 and 18. In No. 49, the healing of the incision was greatly advanced in the control, while only a slight difference of the same type was noted in Nos. 47 and 50.

Rats Nos. 13, 14, killed 9 days after incision.—Little difference was seen in these

TABLE I

	1 day ³			2 days			3 days			4 days			5 days			6 days			7 days			8 days			9 days		
C-E Interval	+	-	T. ⁴	+	-	T.	+	-	T.	+	-	T.	+	-	T.	+	-	T.	+	-	T.	+	-	T.	+	-	T.
0	0	4	4	0	4	4	4	5	9	3	1	4	—	—	—	4	0	4	2	2	4	—	—	—	—	—	—
24 hr.	—	—	—	0	2	2	0	3	3	2	2	4	2	0	2	—	—	—	3	0	3	6	0	6	—	—	—
48 hr.	—	—	—	—	—	—	—	—	—	0	3	3	—	—	—	—	—	—	2	4	6	2	3	5	1	2	3

³Interval between incision and killing of rat.⁴Total number.

Figs. 3-A and 3-B. Rat No. 67. Treated 24 hours after cutting; sections taken 5 days after cutting. *A* (left), treated part; *B* (right), untreated part. The wound slants downward and to the right in *A*. Note lack of marginal fibroblast formation as contrasted with that in *B*.

specimens between treated and untreated halves of the wounds.

In order to provide a comprehensive study of the results obtained, the data are tabulated in Chart I. Representative sections were chosen from different groups for illustration (Figs. 1-6).

DISCUSSION OF RESULTS

In examining the wounds microscopically, we have found that there are striking variations from the normal in the healing of wounds treated by X-rays in the dose used. In an unirradiated incision, active repair begins very soon after cutting, and definite fibroblast formation can be noted by

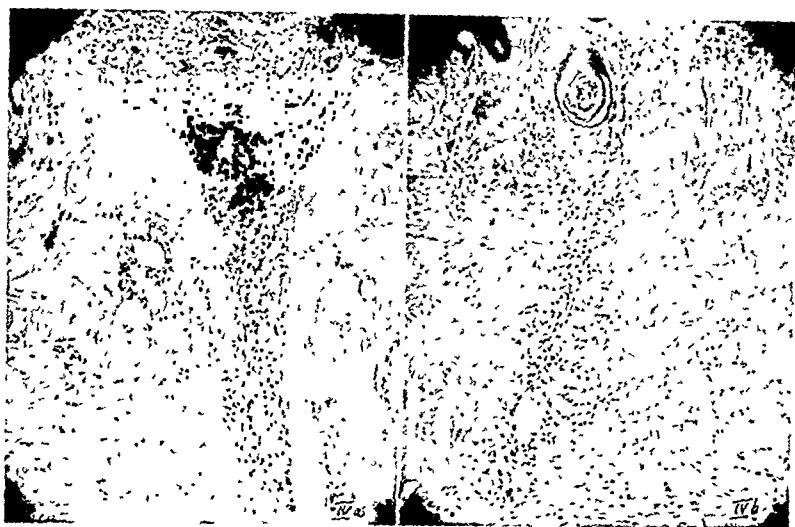
the end of 48 hours at the latest. In the treated portion of a wound, however, there is a definite retardation of this process. The edges of the wound appear inactive and sluggish. Fibroblasts, if noted at all, are seen relatively late, and then in reduced numbers. In addition to this there is distinct irregularity of growth, and the newly formed cells tend to be atypical.

The changes described vary considerably with the different variations in the time elements. The most marked change was noted in those animals in which irradiation took place 24 hours after cutting, and the difference between irradiated and control tissues began to be evident from three to four days after the cutting, but seemed most ap-

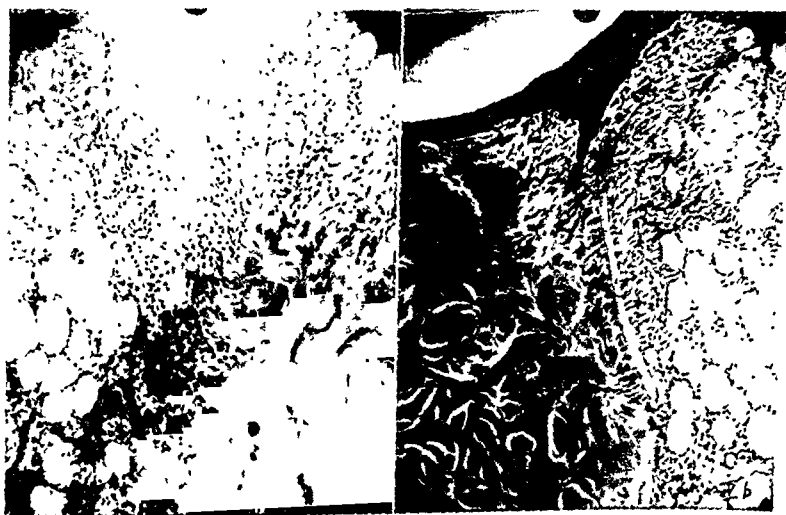
parent about seven or eight days after the wound was made.

In certain animals there was no appre-

ment in the different groups is difficult, and its value becomes extremely doubtful when we consider the variable reaction to the



Figs. 4-A and 4-B. Rat No. 10. Treated 24 hours after cutting; sections taken 8 days after cutting. *A* (left), treated part; *B* (right), untreated part. Differences noted as in Figures 3-A and 3-B.



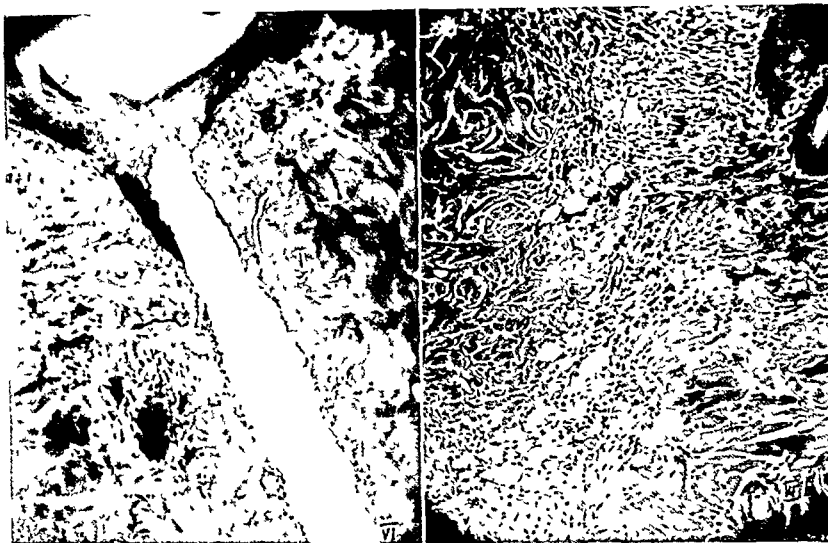
Figs 5-A and 5-B Rat No. 17. Treated 48 hours after cutting, sections taken 7 days after cutting. *A* (left), treated part; *B* (right), untreated part. Note difference in direction of fibroblast growth. In *A*, growth is toward surface from the deeper parts; in *B*, straight across the wound.

ciable difference between the exposed and unexposed parts of the wounds. A qualitative evaluation of the effects of the treat-

same treatment in different individuals. We have endeavored, therefore, to express our results quantitatively, counting as positive

those wounds in which there could be no doubt as to the difference in the two halves. This evaluation is easily expressed, then,

on that of the underlying connective tissue, so that in many cases there is a complete restitution of the epithelial covering while



Figs. 6-A and 6-B Rat No. 49. Treated 48 hours after cutting; sections taken 8 days after cutting. *A* (left), treated part; *B* (right), untreated part. Contrast obvious. Note also the healing over of epithelium, with almost entire inactivity of underlying connective tissue.

when one states the proportion of positive results in each group (Table I).

A study of Table I shows that the most constant positive results are seen in wounds treated 24 hours after cutting, while those which were treated with no C-E (cutting-exposure) interval or after 48 hours showed a definitely higher proportion of negative findings.

Three points of especial interest may be emphasized here. In the first place, it was found that in different animals there were distinct variations in reaction, though the animals had been treated exactly alike, within limits of human error. This merely illustrates the well-known principle, forgotten by many writers, of individual variation in laboratory animals as well as in human patients.

Secondly, the irradiation seems to have less effect on the growth of epithelium than

the deeper part of the wound is far from being completely healed. This phenomenon may account for some of the conflicting opinions as to clinical results; that is, superficial gross appearances are deceptive, and one may think that an irradiated wound is healing rapidly, whereas microscopic examination of the underlying tissues would lead to the opposite conclusion.

Lastly, it is apparent that in many cases the upper layers of the connective tissue have suffered most, so that there was active connective tissue proliferation in the deeper part of a wound while the superficial parts still showed a well-marked inactivity. In view of the fact that there is little loss of radiant energy in the first centimeter of tissue, it seems improbable that this observation could be explained on the basis of the absorption law.

SUMMARY

1. Seventy-eight rats were exposed to roentgen rays (100 K.V., 2 mm. Al) immediately, 24 hours, and 48 hours following incisions in the skin of the back. Half of each wound was irradiated following the cutting and the other half was protected. Sections were made of specimens taken at daily intervals from one to nine days after the incisions. Twelve animals were dis-

carded on account of infection of the wounds.

2. Delay in healing was most constantly observed in wounds treated 24 hours after cutting. Histologically this became evident from three to four days after the cutting, but seemed most apparent about seven or eight days following incision. The irradiation seems to have less effect on the epithelium than on underlying connective tissue.

DIAGNOSIS AND ROENTGENOLOGIC EVIDENCE IN SPONDYLOLISTHESIS¹

By HENRY W. MEYERDING, M.D.,

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SUBLUXATION of the spine, spondylolisthesis, formerly considered a rare deformity and reported by obstetricians as occurring more often among women, is now more frequently recognized, and is found to be common among men. This is the result of more careful analysis of clinical observations and improved technic of roentgenologic examination of patients complaining of pain low in the back. Of the 125 cases reported previous to 1900, only about 5 per cent were males. Of the patients coming to the Mayo Clinic, 71 per cent were males.

Even though a clinical diagnosis of spondylolisthesis is made, the roentgenogram is indispensable in proving its presence. The roentgenologist is called on to determine the site of the subluxation, its extent, the presence of predisposing factors (such as congenital deformities), to find evidence of fracture, and to rule out complications. With modern equipment and technic the roentgenograms, properly interpreted, often permit solution of the etiologic factors: trauma and congenital defects.

I believe that this deformity is not gen-

erally recognized by the medical profession; the condition had been diagnosed in less than 10 per cent of the cases I have observed. In 1921 at the Mayo Clinic, a diagnosis had been made in only two cases; in 1930 it was made in 41 cases (0.054 per cent), and, in the first nine months of 1931, in 46 cases (0.092 per cent). The average diagnosis in more than 500,000 cases was 0.023 per cent, which is probably still too low.

The patients with spondylolisthesis who are usually seen in the clinic are farmers, laborers, and their wives (64 per cent). The average duration of symptoms had been 8.75 years. The ages were from 11 to 80 years; the average age was 40 years, and 80 per cent of the patients were between 20 and 60 years. Males constituted 71 per cent, and females 29 per cent, in a series of 207 patients observed at the Clinic.

Patients with spondylolisthesis may not have symptoms and may not be aware of the presence of deformity; 9 per cent of the cases in the Clinic were discovered incidentally. Acute spondylolisthesis of traumatic origin may produce immediate and total disability, accompanied by excruciating pain and apparent paralysis. Symptoms may

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

occur long after the injury and subluxation; they may be aggravated by stress and strain. Vague pain in the legs was the symptom which led to discovery of spondylolisthesis in 5 per cent of cases; pain in the legs, thighs, and hips, associated with backache, in 36 per cent. Chronic backache, however, was the principal complaint in 50 per cent. Thus, 86 per cent of these patients with spondylolisthesis complained of backache or 'sacro-iliac pain with or without pain in the legs. Weakness was manifest in 5 per cent and numbness in 10 per cent of the cases. In many cases, roentgenograms of the spinal column had been interpreted as negative, and, on inquiry, it was found that only anteroposterior views had been made. The subjective symptoms might easily be construed as those of "railroad spine," "traumatic spine," or "neurosis," unless careful inspection of the back and palpation suggested the possibility of subluxation and led to proper roentgenologic examination. If the individual appears to be otherwise healthy and is gaining in weight, pain low in the back, producing partial disability which is relieved by rest and is aggravated by work, is often suspected of being due to malingering. I believe that many so-called sacro-iliac strains are in reality injuries to the lumbosacral articulation in which there is no demonstrable clinical or roentgenologic lesion.

The spinal column may appear normal or grossly deformed, depending on the situation and degree of subluxation. It may not be possible to discern displacements graded 1 either on inspection or on palpation, but, as deformity graded 2 is approached, a definite depression of the lumbar spinous process is observed. The fifth lumbar process and the sacrum become more prominent, and the erector spinæ stand out and may be spastic to varying degrees. If the thumb is brought down along the spinous processes, it will sink in a lumbar lordosis in a depression, and come to rest on a ledge made by



Fig. 1. Spondylolisthesis of the fifth lumbar vertebra. Lordosis, deep shadow, prominent sacrum, short torso, and broad pelvis may be noted.

the fifth spinous process and the sacrum (Fig. 1). If light strikes the back from the side, it casts a dark shadow in the groove between the muscles in the lumbar lordosis, whereas the high light appears on the prominence of the sacrum. I speak of the "depression" and the "prominence" in describing this.

Spinal curvature and tilting of the spinal

column are not uncommon. As the subluxation increases, the entire torso becomes altered. In deformities graded 3 and 4, the torso is definitely shortened, marked lordosis appears, and the ribs sink into the pelvis

pelvis, due to the fifth lumbar vertebra slipping forward and downward.

Occupations which require *stooping* and *lifting* and the carrying of heavy burdens are unbearable to some patients. The gait



Fig 2. Traumatic spondylolisthesis (graded 2) of the fifth lumbar vertebra on the sacrum and lateral spondylolisthesis of the fourth on the fifth lumbar vertebra. The injury had been received 30 years previous to the examination. *A* (left), anteroposterior view; *B* (right), lateral view.

with a deep crease forming in the loin and across a short and often prominent abdomen. The depression is marked, the sacrum stands out prominently, and, on percussion and deep palpation, spasm of muscle and tenderness of the lumbosacral region are noted. The pelvis appears broadened, with bulging of the flesh about the ilia. Motion of the spinal column becomes limited; lateral motion may be fairly normal, and posterior and especially anterior motion are sharply limited. Some patients fear to bend backward because of feeling a "sharp stabbing pain" or "something giving way." In the presence of such marked deformity, low abdominal palpation may disclose a bony mass in the median line. Proctoscopic or rectal palpation discloses narrowing of the

may vary from normal to guarded, or even waddling. Jarring and jolting of the spinal column, except in cases of acute spondylolisthesis, are never so painful as in cases of bercuriosis. Spondylitis with lipping, which occurs in about 20 per cent of cases, may account for some of the complaints.

Neurologic signs are usually absent unless congenital defects or severe trauma affect the cord; approximately 86 per cent of these defects occur between the fifth lumbar vertebra and the sacrum, at which level complete paraplegia does not take place. Saddle areas of paresthesia are common. Inspection and palpation, therefore, vary with the degree of subluxation. The clinical diagnosis is usually made in severe cases.

Modern roentgenologic examinations have

shown great frequency of congenital anomalies of the fifth lumbar vertebra and the first sacral vertebra. No doubt many anomalies, which are seldom the cause of symptoms, still escape detection. Under long-con-

the fifth vertebra are no longer kept from slipping over the superior articular processes, especially when there is separation of the neural arch by fracture or defect.

Congenital defects may be present a life-

Types of Spondylolisthesis

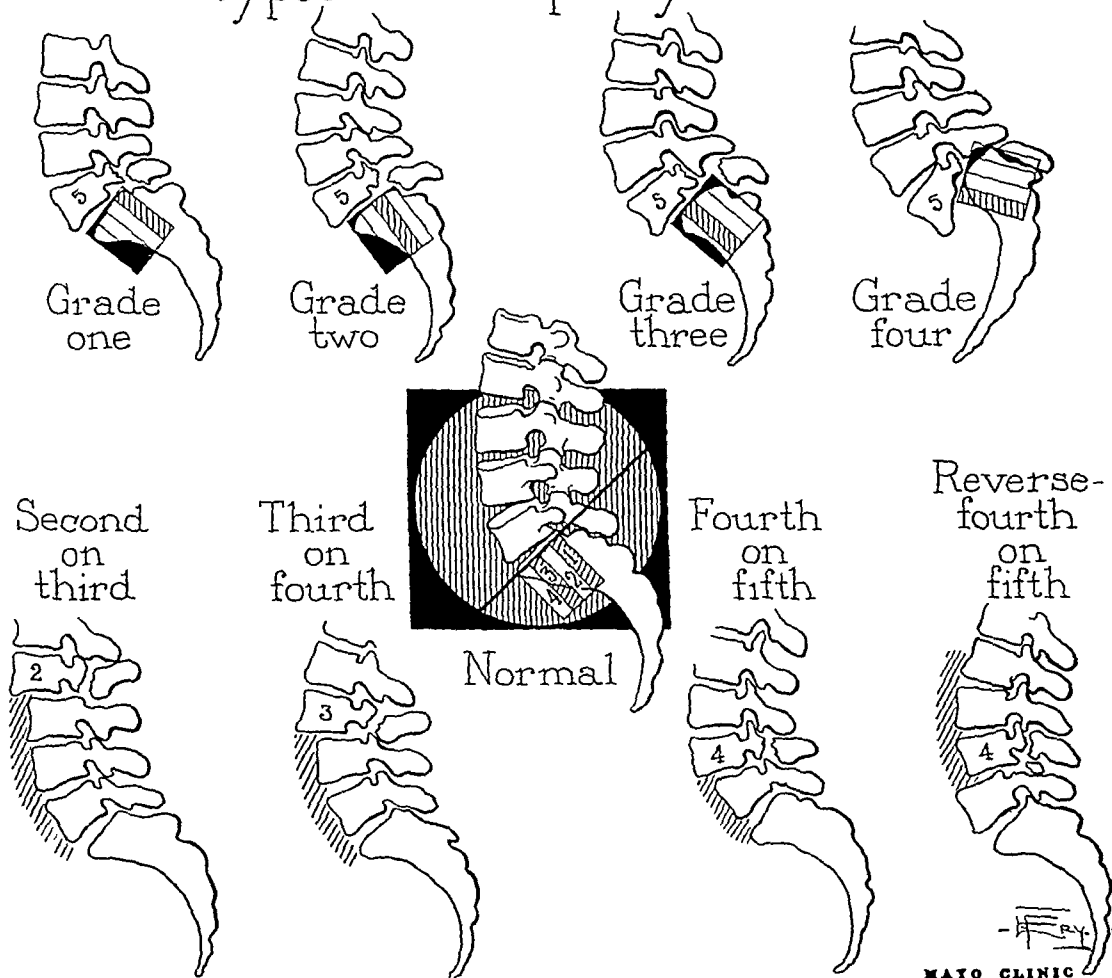


Fig. 3. Gradation of displacements.

tinued strain or pregnancy, sudden, severe injury may prove too great a test, and these weakened structures, with imperfect muscular and ligamentous support, may be incapable of maintaining their normal relationship. Lordosis occurs, the angle of the lumbosacral joint becomes more perpendicular, and the inferior articular processes of

time without the patient's knowledge. Even subluxation of the spinal column may exist to a marked degree without symptoms; nevertheless, I believe that trauma is often the exciting cause of pain and disability. When trauma focuses the attention on the lower part of the back and the roentgenogram proves the presence of subluxation, it

does not prove that the spondylolisthesis was due to the injury, although the symptoms of pain in the back, previously absent, may be present (Figs. 2-A and 2-B). A diagnosis of traumatic spondylolisthesis may be made,

shown in almost 70 per cent of the proved cases of spondylolisthesis. Lateral views are most important, as the diagnosis in Grade 1 is often impossible from the anteroposterior views alone. As the displacement increases

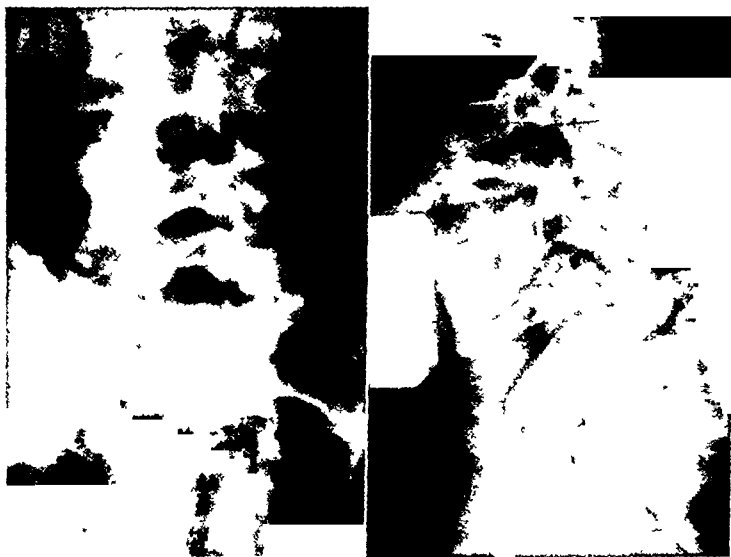


Fig 4 Spondylolisthesis (graded 3) of the fifth lumbar vertebra on the sacrum, with spina bifida occulta. The patient was a laborer, aged 25 years, with chronic backache, leg ache, and weakness. *A* (left), anteroposterior view, *B* (right), lateral view, with slipping of the sacral promontory

but it may be difficult to prove it unless roentgenograms previous to injury are available, or unless corroboratory evidence of fracture, callus, and so forth, are present. With the employment of modern technic, anomalies, fractures, degree of spondylolisthesis, and lateral displacements may be studied from various angles by means of anteroposterior, lateral, and stereoscopic roentgenograms, and the factors involved in etiology may be considered with relation to the history or physical state. Thus the expert roentgenologist is in the most favored position to solve the problems confronting the medical profession in regard to spondylolisthesis. In reviewing anteroposterior roentgenograms, some degree of superimposed fifth lumbar vertebra on the sacrum was

to the second, third, and fourth stages, the lumbar spinous process becomes shortened, and the fifth lumbar vertebra is superimposed on the sacrum, as shown by increased density, often clearly outlined. Only four lumbar vertebrae may be visible above the sacrum and there may be lateral displacement of the spinal column on the sacrum. The ribs appear so close to the pelvis as to seem to rest on it. The spinous process and transverse processes of the lower lumbar vertebrae may be tilted upward. Spina bifida occulta is observed in about 35 per cent of roentgenograms.

Lateral roentgenograms permit the grading of displacement. If the fifth lumbar vertebra slips forward less than a fourth the distance across the lumbosacral joint, it is

graded 1; if it slips less than half-way across, it is graded 2; if less than three-fourths, it is graded 3, and if more than three-fourths, it is graded 4 (Fig. 3). The angle of the lumbosacral joint varies from

the patients averaged 8.75 years, the roentgenograms were sometimes faded or damaged, and it was not always possible to determine the exact nature of the anomaly. I have used the term "separation of the neural

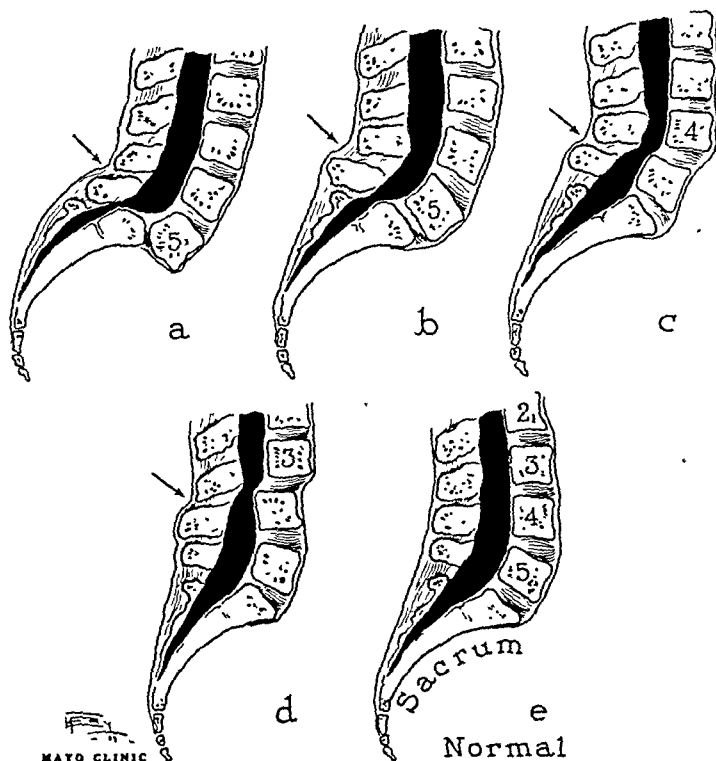


Fig. 5. The effect of spondylolisthesis on the spinal canal, sagittal section. *A*, involving the lumbosacral joint, graded 3; *B*, involving the lumbosacral joint, graded 1; *C*, involving the fourth and fifth lumbar vertebrae, graded 1; *D*, involving the third and fourth lumbar vertebrae, graded 2, and *E*, normal section through lumbosacral area. Arrows indicate depression.

normal to perpendicular and the fifth lumbar vertebra may lie entirely displaced in front of the sacrum, with its articular surface facing the anterior pelvic border of the sacrum. The fourth lumbar vertebra forces its way to rest on the sacrum.

Thus the degree of displacement and the angle of the lumbosacral joint vary amazingly. Rudimentary vertebrae or a sixth lumbar vertebra may be present. The condition of the neural arch and isthmus, whether elongated, fractured, or separated by congenital defect, may be noted. As the complaints of

arch" broadly to cover any defect, whether of traumatic or congenital origin. In a series of 48 more recent lateral roentgenograms, separation of the neural arch was discernible in 70 per cent of the cases (Figs. 4-A and 4-B). The sacral promontory appeared lipped in 15 per cent of cases and sheared off, with the sacral articulating surface semicircular in 15 per cent. The size and shape of the fifth lumbar vertebra varied greatly; in 54 per cent, the vertebra often appeared smaller and flattened behind. The shape and width of the lumbosacral joint, as

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trapping of her back had afforded some relief, and she wore a belt with some benefit. Laminectomy had been performed.

Examination disclosed shortening of the os, lordosis, and prominence of the fifth

and recognized only after symptoms appeared.

Case 2. A farm hand, aged 17 years, consulted the Clinic in 1928 because of flat-feet and pain in the knee. He did not complain



Fig 7 Spondylolisthesis (graded 1) of the third on the fourth lumbar vertebra A (left), anteroposterior view; B (right), lateral view

spinous process of the sacrum. Anteroposterior roentgenograms disclosed a shortened lumbar spinous process, spina bifida occulta, and superimposed fifth lumbar vertebra on the sacrum. The lateral views disclosed spondylolisthesis (graded 2) of the fifth lumbar vertebra on the sacrum. The fifth lumbar body was narrowed posteriorly and the lumbosacral articulation was slightly narrow. The neural arch was distinctly separated.

Was the spondylolisthesis in this case present before the injury? Did injury disrupt the weakened support to the lumbosacral articulation and cause spondylolisthesis? Injury initiated the symptoms, and deformity had not been noticed. Callus could not be made out at the separation of the neural arch. It could be, and probably was, a congenital defect, strained by accident,

of deformity or pain in the lumbosacral region, but a small prominence in this area led to the taking of roentgenograms. They disclosed spondylolisthesis of the fifth lumbar vertebra on the sacrum. The boy is carrying on his work. Should he meet with an accident, it will be of interest to note the effect it will have in producing pain and disability.

Case 3. A farmer, aged 36 years, complained of pain in the back and hips. Ten years previous to examination he had been crushed between a stone wall and a truck. His back was strapped and he used crutches for a time. Pain continued, and he sought relief for a chronic cough and stomach trouble.

Examination disclosed a depression over the fourth lumbar vertebra. Roentgenograms of the spinal column showed spon-

well as the angle, presented many variations. In 40 per cent, the posterior edge of the body of the fifth lumbar vertebra appeared to be driven downward and forward to the sacrum, the intervertebral disk apparently

The anteroposterior roentgenograms would be of little value in the diagnosis of reverse spondylolisthesis.

I have found the most frequent form of spondylolisthesis to be the slipping forward



Fig 6 Spondylolisthesis (graded 4) of the fifth lumbar vertebra on the sacrum. The patient, a laborer, aged 20 years, complained of stiffness and a lump on the back which had been diagnosed tuberculosis of the spinal column. *A* (left), anteroposterior view of the fourth lumbar vertebra above the sacrum; the fifth is superimposed on the sacrum and clearly outlined on an area of increased density. *B* (right), lateral view of rounded articular surface of the sacrum and wedge-shaped fifth lumbar vertebra.

was forced ahead, widely separating the lumbosacral articulation anteriorly. Minor variations were shown (Fig. 5). The spinal canal in these cases becomes distorted and narrowed, and, in tracing it, one may gauge the presence of lesser displacements of the vertebra more readily than from a study of the anterior border of the lumbar spinous processes and sacrum.

Instead of a forward displacement of the spinal column and torso, a backward slipping may take place, producing reverse spondylolisthesis (Figs 6-A and 6-B). In four of these cases I have observed the deformity was marked in none; the displacement, however, was obvious in lateral roentgenograms, and a small gibbus was palpable.

of the fifth lumbar vertebra on the sacrum. This occurred in 86 per cent of the cases. The fourth lumbar vertebra slipped forward on the fifth lumbar vertebra in 11 per cent (Figs. 7-A and 7-B), the third lumbar vertebra on the fourth lumbar vertebra in 1 per cent, and reverse spondylolisthesis occurred in 2 per cent.

CASE REPORTS

Case 1. A girl, aged 19 years, complained of backache following an automobile accident 14 months previous to examination. She recalled having later lifted something and injuring her back, and pain developed in her legs, associated with chronic backache.

her health was good, and she felt well when wearing the support to the back.

Evidence obtained from available roentgenograms makes it probable that a mild degree of spondylolisthesis (graded 1) existed,

plained of leukorrhea, hot flashes, and constipation. A cyst of the uterus had been diagnosed. She had been treated for stomach trouble, and a chronically inflamed appendix had been removed and the abdomen

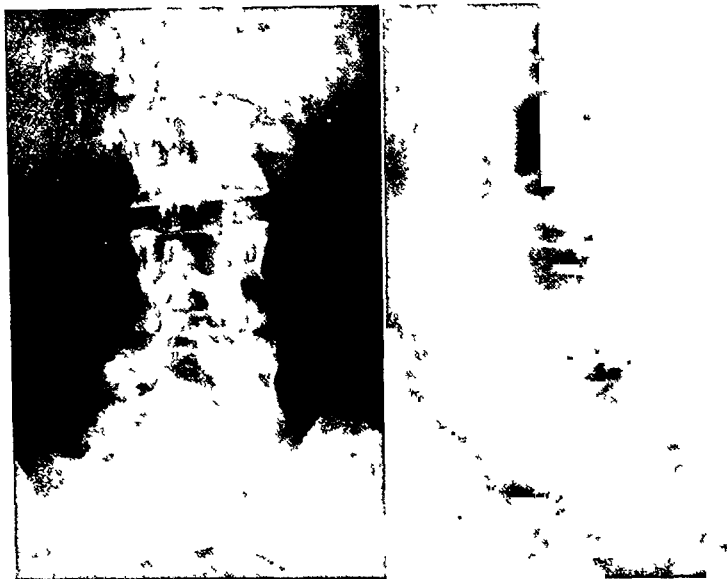


Fig 9 (Case 5) Spondylolisthesis (graded 2), of fourth lumbar vertebra on fifth lumbar vertebra A (left), anteroposterior view, B (right), lateral view

as was first suspected, since, in the anteroposterior views of the lumbosacral region, the fifth lumbar vertebra was superimposed on the sacrum. The first lateral views were not found, but, after a two months' interval, deformity (graded 1) was obvious in the lateral views; the same degree of superimposition of the lumbosacral vertebra existed as at the first examination. The suggestion of symptoms by the physician to the introspective patient led to prompt assimilation and complaint, although the deformity had previously existed and pain had not been present. Again reassurance and support of the spinal column were enough to afford relief of the symptoms, after diagnosis had been verified. What the effect of an industrial injury to the back would have been can readily be surmised.

Case 5. A housewife, aged 47 years, com-

explored. Roentgenograms of the stomach, kidneys, ureters, and bladder had been made 12 years before with negative results. On further questioning, the patient admitted having pain, which was aggravated by work, between the shoulder blades.

Examination of the spinal column disclosed a typical depression, with prominence of the fifth lumbar vertebra, muscle spasm, limited spinal motion, especially on forward bending, and tenderness on firm pressure and percussion of the lumbar portion of the spinal column and right costal arch. The patient did not remember any injury and had never received treatment for trouble of the spinal column. *Trichomonas vaginalis* were found. Roentgenograms of the thorax and stomach were negative. Lateral roentgenograms showed spondylolisthesis of the fourth lumbar vertebra on the fifth (Figs.

dylolisthesis of the fourth lumbar vertebra on the fifth. Duodenal ulcer and chronic bronchitis were also found. The patient refused operation.

This type of severe injury, involvement of

She returned two months later. Symptoms referable to the bladder had disappeared, but now she complained of backache, pain in the sacro-iliac joints, and a "tight feeling" in the thighs and legs. She wore a



Fig 8 (Case 4) Spondylolisthesis (graded 1) of fifth lumbar vertebra on sacrum *A* (left) anteroposterior view, *B* (right), lateral view

the fourth lumbar vertebra, and sudden onset of pain, in a robust, hard-working farmer, would indicate the traumatic origin of the displacement.

Case 4 A housewife, aged 38 years, complained of irritability of the bladder and weakness. She was nervous and consulted many physicians. She had been treated for constipation, hemorrhoids, cystic cervix, dental sepsis, eye trouble, and headache.

Roentgenograms of the kidneys, ureters, and bladder suggested the possibility of spondylolisthesis, but lateral views were interpreted as negative. The orthopedic consultant noted a rather acute angle of the fifth lumbar vertebra on the sacrum, but no definite slipping. The patient was questioned but she denied all symptoms of spondylolisthesis. She was urged to protect her spinal column by wearing a support.

corset, and complained of abdominal fullness, belching, and nervousness. There was no loss of weight and no weakness. Examinations of the urine, of the eyes, ears, nose, and throat were negative as was the Wassermann reaction of the blood. It was suspected that the spinal symptoms were partly due to nervousness (Figs 8-A and 8-B). The roentgenologist made the diagnosis of spondylolisthesis of the fifth lumbar vertebra on the sacrum. The neurologist's report concerning the central nervous system was negative. The subjective symptoms were in the midthoracic and lumbar portions of the spinal column, and a depression above the sacrum was noted. The patient was treated for hemorrhoids and anal fissure and she returned home wearing a corset. Four months later she again returned, having gained 18 pounds in weight. She stated that

the upper border of the sacrum and limited mobility of the lumbar portion of the spinal column. A small area of anesthesia overlying the coccyx and moderate tenderness over the right border of the lumbar portion

lumbar vertebra was displaced forward so that the posterior quarter of the body rested on the anterior part of the sacrum. Spina bifida occulta was evident in the anteroposterior views.

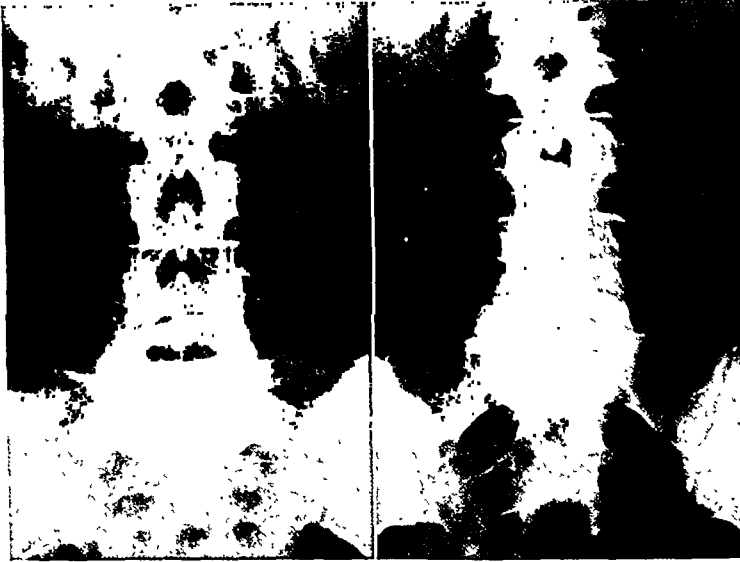


Fig. 11 (Case 8). *A* (left), pre-operative anteroposterior view of spondylolisthesis graded 3. *B* (right), post-operative anteroposterior view showing author's method of using two bone grafts and multiple bone chips to fuse the third, fourth, and fifth lumbar vertebrae and the sacrum.

of the spinal column were noted. Roentgenograms showed spondylolisthesis of the lumbosacral joint and fractures of the transverse processes of the second, third, fourth, and fifth lumbar vertebrae on the right side.

The patient was operated on March 16, 1929, and the third, fourth, and fifth lumbar vertebrae were fused in the sacrum. Improvement followed (Figs. 11-*A* and 11-*B*).

Case 8. A farm youth, aged 19 years, complained of pain in the back of two years' duration, which had been ascribed to rheumatism. Pain and swelling in the other joints indicated the presence of complicating arthritis, but general examination disclosed the short waist, the depression over the fifth lumbar vertebra, the spasm of muscles, and the limitation of motion. A clinical diagnosis of spondylolisthesis was made and verified by roentgenograms. The entire fifth

A bone-grafting operation was performed and the symptoms in the back were relieved.

SUMMARY

Of the patients examined, 64 per cent were hard-working people. Their average age was 40 years and 71 per cent were men. The principal complaint was backache of almost nine years' duration. Although many patients had consulted physicians, and roentgenograms had been made, less than 10 per cent had been given a diagnosis.

Symptoms are relieved by rest; hard work, especially stooping and lifting, aggravate them. The patient may appear well and be gaining in weight. The anteroposterior roentgenogram may appear to be negative. Malingering may be suspected when the subluxation is slight and discernible only in lateral roentgenograms. Clinical

9-A and 9-B). Neurologic examination and the Wassermann reaction of the blood were negative. The patient was not concerned about the spondylolisthesis and did not wish to submit to any treatment, although she ad-

lumbar vertebra was discovered, and he was referred to the Mayo Clinic.

Examination disclosed typical signs of spondylolisthesis of the fifth lumbar vertebra on the sacrum (Figs. 10-A and 10-B).



Fig 10 (Case 6) Spondylolisthesis (graded 3), fifth lumbar vertebra on the sacrum *A* (left), anteroposterior view, *B* (right), lateral view.

mitted having had backache all her life. In this case a severe injury would, no doubt, aggravate the condition and produce more definite symptoms.

Case 6. A youth, aged 17 years, had complained of aching pain in the left hip for two years. He thought he had always had a weak back, and working in the fields and stooping tired him more than it should have. Three years previous to admission he had fallen down twelve steps, and two years previously, while driving a cultivator, his left leg tired and ached, and he had to stop work and lie down at intervals in the field. In school the next year he had to lean forward and to the right, and stretch the left leg to relieve pain in the back. He consulted an orthopedist, and arthrodesis of the left sacro-iliac joint was performed without relief of symptoms. On further consultation eight months later, destruction of the fifth

Roentgenograms disclosed spina bifida occulta and superimposed fifth lumbar vertebra on the sacrum. In lateral views, spondylolisthesis (graded 3), with separation of the neural arch, and narrowed fifth lumbar vertebra posteriorly were noted. Operation, with fusion of the lumbosacral region, benefited the condition.

Case 7. A machinist, aged 22 years, was struck across the lower part of the back by a falling tree five months before he came to the Clinic. The injury was followed immediately by paralysis of the sphincters of the rectum and bladder. An area of anesthesia around the anus following the accident. The sphincters slowly regained their power. The legs were not paralyzed. A body cast was applied and was worn for a week, and the patient was kept at rest in bed for two and a half months.

Examination showed a depression above



Fig 1, Case 1 Congenital dislocation, reduced bloodlessly but reduction could not be maintained. Patient was one and a half years of age.

plasticity which is a characteristic of living structures.

According to Wolff's law, the external form and the internal architecture of bone are determined by the mechanical forces which operate upon it, and are altered when the direction of stress and strain is altered. They adapt themselves to changed function and to altered mechanical forces. It is well known that the lamellæ of the head and neck of the femur are designed with exact mathematical precision in this peculiarly shaped bone to bear a given weight with the use of the least amount of material. This bone is as precisely adapted to the demands placed upon it as is a reinforced concrete building or a bridge. If the angle of the neck with the shaft becomes altered by accident or disease so that there arises a coxa vara, Nature proceeds to absorb all the lamellæ. Simultaneously they are replaced with new ones



Fig 2, Case 1 Two and a half years after operation to reconstruct the upper portion of the acetabulum.



Fig 3, Case 2 Congenital dislocation. Patient was twenty years of age.

in different lines of direction which are as mechanically correct as were the old ones, and which bear the body weight with the same paucity of material but the same coefficient of safety. In cases of bony ankylosis of the hip, we frequently observe that Nature

signs vary with the degree of deformity. A typical example discloses depression or lordosis of the lumbar spinous processes with prominence of the fifth lumbar spinous process and sacrum; in 86 per cent of the cases this region is involved. With increased subluxation, shortened torso and broadened pelvis occur; motion of the spinal column is principally limited on forward bending.

Although trauma is significant as an etiologic factor, it may be difficult to prove. The history and clinical data, when substantiated by evidence of fracture in the roentgenogram, are, however, conclusive. Roentgenograms taken previous to injury are seldom available. Symptomless spondylolisthesis occurred in 9 per cent of the cases.

A hard, bony mass is sometimes palpable low in the abdomen. Rectal examination, proctoscopic or manual, may disclose a narrowed anteroposterior diameter of the pelvis.

In about 2 per cent of the cases the spondylolisthesis was of the reverse type.

Congenital anomalies were present in a high percentage of cases.

Spondylolisthesis formerly, and at present, is seldom recognized in general practice. It is obviously associated with chronic back-

ache. Roentgenologists may disclose its presence in spite of negative clinical data. We may look forward to an increasing incidence of this deformity in cases of chronic backache and injury to the spinal column as a result of the more common use of lateral roentgenograms of the lumbosacral area.

DISCUSSION

DR. MEYERDING (closing): Congenital anomalies accompanying spondylolisthesis are common. With better roentgenograms, I believe they will run between 70 and 100 per cent. Many of the older roentgenograms do not give differential evidence and it is impossible to judge the true conditions accurately. I have seen traumatic spondylolisthesis; I admit, however, that he who diagnoses traumatic spondylolisthesis must prove it. Many patients have this deformity with symptoms, but injury may aggravate a pre-existing condition causing pain, increased deformity, and even disability. If these cases are seen immediately, and good anteroposterior and lateral roentgenograms are available, they may show the presence of a fracture with spondylolisthesis. In such a case, there can be no question of what factor trauma has played.

PLASTIC SURGERY OF THE HIP¹

By A. BRUCE GILL, M.D., PHILADELPHIA

PLASTIC substances can be molded easily, as they lend themselves to adaptation by external forces. But animate plastic tissues have an innate power of self-adaptation to changing conditions. Certain tissues of the body can be molded and reshaped by the surgeon's hand. They can be transplanted to other parts of the body, where they may serve a new purpose in the repair of bodily defects, but they also have an inherent capacity to adapt them-

selves to their new surroundings, to take on new functions, and, by growth, to meet greater demands placed upon them.

We have been accustomed to think that the soft tissues of the body are more plastic or changeable than the bones. Plastic surgery, for the most part, has meant the repair of defects of the face and skin grafting, to correct contractures and replace lost tissue. But we have learned that bones are also fit matter for the surgeon's plastic art, and, indeed, present even more remarkable and striking illustrations of that innate

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

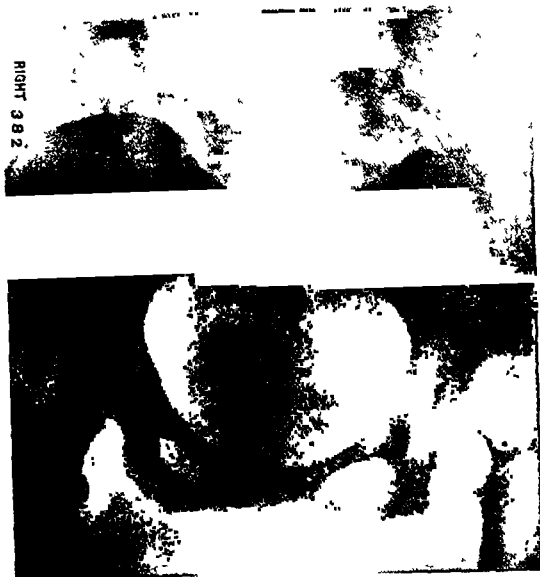


Fig. 7, Case 3. Two and a half years after reconstruction of the acetabulum.

some growth, but eventually it becomes completely absorbed, because it serves no function. If a portion of the fibula be transplanted to take the place of the upper end of the humerus, it will increase in size until it becomes of the same diameter as the humerus itself. A remarkable case was reported by Dr. Willard in which the lower end of a humerus was fractured. The lower fragment, together with the elbow and the forearm, was displaced backward. The posterior portion of the periosteum of the humerus was stripped from the lower half of the shaft and passed as a bridge from the lower fragment to the middle of the shaft. As time passed, this strip of periosteum grew and replaced the lower half of the humerus, the entire lower part of the upper fragment being absorbed. A large mass of bone lost its function and disappeared, while a small strip of periosteum, which preserved the continuity of bone between the shoulder and the elbow, grew to replace the bone whose usefulness was lost.

Therefore, we may see in the bones of the body beautiful illustrations of that inherent plasticity which is common to all liv-



Fig. 8, Case 4. Congenital dislocation of hip.



Fig. 9, Case 4. Two years after reconstruction of a new acetabulum on the side of the ilium. Almost normal motion.

ing tissues and which makes not only their form and structure but their life and death dependent upon function. And we may expect plastic surgery of the bones to give particularly striking results.

Youth is more plastic than age, is more flexible, adapts itself more easily and effectively. Its reserve strength, its coefficient of safety, is greater. Repair is easier. In young bone, increased demand stimulates growth and strength; in aged bones, it may

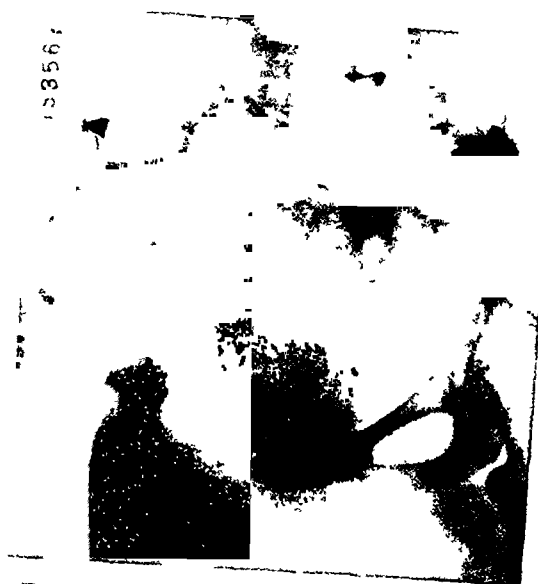


Fig 4, Case 2 Four years after reconstruction of acetabulum normal motion normal function



Fig 5, Case 3 Congenital dislocation Patient was seventeen years of age

has laid down lamellæ which arise in the bones of the pelvis and sweep downward in curved, unbroken lines through the head and neck of the femur. The direction and curve of these lines may be entirely different from those of the normal femur, because the line of weight-bearing is different. A change of function has brought about a complete change of architecture. Here is an



Fig 6, Case 3 Six months after reconstruction of the acetabulum

exhibition of plastic power which soft tissues cannot surpass.

But there is another natural law, even more profound and mysterious than that enunciated by Julius Wolff. It is indeed amazing that Nature should construct her buildings in accordance with the laws of calculus and higher mathematics, that she should provide a maximum of efficiency with a minimum of materials, and, still more so, that she can tear down a structure and replace it with another without interruption of the continuity of its usefulness. But is it not more amazing to learn that growth and the very existence of a structure are dependent upon its serving a useful function in the body? The roots and ramifications of this law would lead us into the mysteries of all life and growth and into the secrets of evolution. But time and again we see it illustrated in the bony structures of the body.

If an emulsion of periosteum and bone be injected into the abdominal wall, it may form a plate of bone and show evidence of



Fig. 7, Case 3. Two and a half years after reconstruction of the acetabulum.

some growth, but eventually it becomes completely absorbed, because it serves no function. If a portion of the fibula be transplanted to take the place of the upper end of the humerus, it will increase in size until it becomes of the same diameter as the humerus itself. A remarkable case was reported by Dr. Willard in which the lower end of a humerus was fractured. The lower fragment, together with the elbow and the forearm, was displaced backward. The posterior portion of the periosteum of the humerus was stripped from the lower half of the shaft and passed as a bridge from the lower fragment to the middle of the shaft. As time passed, this strip of periosteum grew and replaced the lower half of the humerus, the entire lower part of the upper fragment being absorbed. A large mass of bone lost its function and disappeared, while a small strip of periosteum, which preserved the continuity of bone between the shoulder and the elbow, grew to replace the bone whose usefulness was lost.

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Fig 10, Case 5 Pathological dislocation of hip due to tuberculosis

cause degeneration and a breaking down. In young individuals, we see a building up of bone if it is necessary and an absorption of unnecessary bone, a rounding and smoothing of a reconstructed joint such as the hip. In the aged, we observe the degenerative changes of osteo-arthritis following injury to the hip, or caused by the wear and tear of even normal function. There is fibrillation and splitting of the articular cartilage followed by its absorption, the formation of osteophytes from the subchondral bone, and a general roughening and irregularity of joint surfaces and margins.

These various characteristics of bone are well illustrated in certain conditions of the hip joint and in the reactions of the tissues following plastic operations.



Fig 11, Case 5 Six years after reconstruction of the acetabulum with reduction



Fig 12, Case 6 Pathologic dislocation due to tuberculosis.

CONGENITAL AND PATHOLOGIC DISLOCATIONS

In congenital dislocations of the hip, we note the shallowness of the acetabulum, the lack of normal development of the epiphysis of the head of the femur, the misshapen head, the small size of the neck and shaft, and the version of the neck. All these conditions may be explained by the absence of normal function of the hip both before and after birth. As years pass the acetabulum



Fig 13, Case 6 Four years after fusion of the femur with the pelvis Note the marked growth of the femur and pelvis



Fig 14, Case 7 Old ununited fracture of the neck of the femur necrosis of the head complete absorption of the neck

becomes more and more shallow and eventually may entirely disappear. It has become a useless structure and ceases to exist. Nature, in the meantime, is attempting to construct a new socket higher up on the pelvis although in this effort she is never completely successful. If normal relationship of the acetabulum and the head of the femur be restored and function resumed, Nature returns to her labor of growth and of remodeling of the structures.

The surgeon is able to inaugurate this work by replacing the head in the socket. If the latter is too small to contain the head, it may be deepened or reinforced by a bone shelf turned down from the side of the ilium. If, in old cases of dislocation, the head cannot be brought down to the site of the original acetabulum, a crude acetabulum may be constructed on the side of the pelvis above its normal situation. Nature then proceeds to strengthen this structure, to smooth it and round it neatly to fit the head. Figures 1-9 illustrate these processes in various stages. While we have found that a stable weight-bearing hip is always secured, the degree of mobility varies in different



Fig 15, Case 7 Whitman reconstruction operation.

types of cases. When an entirely new acetabulum must be constructed high on the ilium, motion may be greatly limited, but it is frequently observed that, even in these



Fig 16, Case 8 Fracture of the neck of the femur



Fig 17, Case 8 Almost complete absorption of the neck in three months

cases, the function improves indefinitely as Nature continues her modeling of the new joint.

Figure 1 shows the hip of a child one and a half years of age. Bloodless reduction had been secured, but it was found after six months' treatment in plaster casts that the femur would not remain in the socket. By an extra-capsular operation a bone flap was turned down from the ilium and the entire roof of the acetabulum was also forced downward. Both structures were held in their new position by bone wedges removed from the crest of the ilium. The final result two years later is shown in Figure 2. In such a reconstructed hip stability and motion are normal.

Figure 3 shows a subluxation in a patient twenty years of age. An operation similar to the preceding one was done. The result four years after operation is shown in Figure 4. Here, also, function is normal.

In Figures 5, 6 and 7 are illustrated the slightly higher luxations where a new acetabulum is made just above the original one. The capsule is opened. The upper rim of the acetabulum is gouged away until the head of the femur slips into the cavity. The structure is then made large enough with a bone flap to contain the entire femoral head. Motion is frequently moderately limited but is sufficient for normal activities.

Figures 8 and 9 show a new acetabulum constructed high in the ilium. In these, motion is still more limited, but at times, as in this case, it approaches the normal.

The development of these plastic operations has completely changed our methods of treatment of congenital dislocation of the hip. The author attempts a bloodless reduction in all cases under from four to six years of age. If it cannot be secured by gentle manipulation or i



Fig. 18, Case 8. Arthrodesis of the hip.

be maintained after from four to six months in plaster, he then resorts to open operation. In former years nothing could be done for the cases that could not be reduced bloodlessly, or that would not remain reduced. Now we have a procedure for every condition, even in patients over twenty years of age. Bloodless reduction, even in children under four years of age, never gave a good result in more than 65 per cent of cases. Now we may expect the successful restoration of a normal hip in the remaining 35 per cent by open operation.

Pathologic dislocations present much the same problems as congenital ones. They are due to infectious processes which destroy the acetabulum or the head, or both, so that subluxations or complete luxations occur. In some cases, a new joint may be constructed which is both stable and movable; in others, an arthrodesis, or fusion of the

femur with the pelvis, is the best solution of the problem. A single rigid painless hip is not a great handicap to the patient. He can engage in most of the normal activities of life; he can do everything but lace his own shoe. Figures 10, 11, and 12 show different types of these cases. Figure 13 illustrates beautifully the growth of the femur after weight-bearing function is resumed.

ANKYLOSIS OF THE HIP

At times it is desirable to restore motion in an ankylosed hip. This may be done by an arthroplasty, the indications for which, and the technic, have been so frequently described that they need not be repeated here. The author has had one occasion to open a joint a year after arthroplasty had been performed and he then observed how natural processes had smoothed and rounded the head of the femur and the acetabulum after function of motion had been re-established.

FRACTURES OF THE NECK OF THE FEMUR

Ununited fractures of the neck of the femur fall within the field of plastic bone surgery. In a certain percentage of them, union may be secured by a bone graft, but grafting is useless unless union of the two fragments occurs. It has been observed that, for a time, a bone graft alone is able to bear the weight of the patient, but that eventually it is absorbed, and, unless union of the fragments has taken place, the condition of the patient is the same as before operation. By what means may it be known whether or not union may be expected to follow operation? The unfavorable cases are those in which complete, or almost complete, absorption of the neck has taken place and those in which the absorption was apparent soon after the fracture and progressed rapidly. It is essential, when the X-ray examination is made, that the femur should not be in a position of either internal or external rotation. Complete death of the femoral head,



Fig. 16, Case 8 Fracture of the neck of the femur.



Fig. 17, Case 8 Almost complete absorption of the neck in three months

cases, the function improves indefinitely as Nature continues her modeling of the new joint.

Figure 1 shows the hip of a child one and a half years of age. Bloodless reduction had been secured, but it was found after six months' treatment in plaster casts that the femur would not remain in the socket. By an extra-capsular operation a bone flap was turned down from the ilium and the entire roof of the acetabulum was also forced downward. Both structures were held in their new position by bone wedges removed from the crest of the ilium. The final result two years later is shown in Figure 2. In such a reconstructed hip stability and motion are normal.

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The development of these plastic operations has completely changed our methods of treatment of congenital dislocation of the hip. The author attempts a bloodless reduction in all cases under from four to six years of age. If it cannot be secured by gentle manipulation or if a reduction cannot

length. These defects have resulted from the relatively small transfer of electricity, the difficulty of maintaining an extensive insulation, necessary along the connecting cable or rod, the insecurity of construction, and absorption by, and secondary radiation from, the walls of the chamber. Fortunately, the physical dependability of these instruments has been greatly improved during the past few years through the studies of Failla (5), Taylor (6), Glasser (4), and others, together with the support of the manufacturers.

An iontoquantimeter consists of an ionization chamber and an electrometer for the measurement of the electrical transfer resulting from the ionization produced by the traversing radiation. All regions of the instrument, except the ionization chamber, must be shielded against radiation. The small chamber usually consists of a grounded spheroid, or thimble-shaped wall, and a centrally placed charged rod, connected with an electrometer system and well insulated from the frame. The rod can be charged to a saturation potential (4, 12) sufficient to transport all ions by means of a static charger, although a small transformer, or an induction coil, is occasionally used for a source of potential. The rate of loss of a static charge across the chamber can be measured by a simple leaf electroscope, or a string electrometer. The intensity of the current flowing from a more sustained source across the chamber can be measured by a sensitive galvanometer, a micro-ammeter, or a potentiometer with a vacuum tube amplifier (7). The most generally dependable electrical system in the portable small chamber instrument appears to be a reliable, built-in, static charger and a simple string electrometer.

A means must be available whereby the constancy of the calibration can be periodically checked. The constancy of the response of the instrument to radiation can be

checked by a radium standard (9, 10). Given a particular 5 mg. needle, replaced in the same definite relations to the chamber, the ionization will be identical and the electrometer reading may be reproduced, unless the electrical capacity or conductivity of the system has been altered. In case the scale deflection is not reproduced, it will be necessary to correct the readings accordingly, or to have the instrument recalibrated. The Victoreen instrument is provided with a capacity check, whereby an added fixed and definite capacity is added to the system, thereby dissipating the total charge by a constant reproducible deflection. The added condenser may also be made use of in converting an instrument designed as an intensimeter into a dosimeter by means of the increased capacity. All small chamber instruments must be calibrated and checked against a standard chamber (8), preferably against a large air chamber.

In a small chamber instrument, the extensive insulation which must be maintained increases the frequency of leakage. This may introduce a very significant error in small chamber determination, since the total ionization current is relatively low. Leakage appears most troublesome in those instruments provided with long flexible cables. When the leakage is due to a thin film of moisture overlying the insulation, it will frequently cease after the instrument has been in a drier atmosphere for a few hours. A persistent leakage must be deducted from the total electrometer reading. The lower the intensity of radiation measured, the more significant the leakage becomes. The Victoreen "r-meter," which we are now using, shows a negligible leakage of 0.01 r/minute. In case leakage becomes variable or in excess of 10 per cent of the usual determination, the instrument should be overhauled by the maker or a similarly qualified expert.

The ideal chamber possesses a wall having an effective atomic number equal to that

which is indicated by its comparative greater density on the X-ray film, may be considered as a contra-indication to a bone graft operation.

If the surgeon decides against such an operation to secure union, he is then limited to a reconstruction operation. In this procedure he removes the head of the femur, cuts off the greater trochanter and moves it down on the shaft, and places the upper end of the femur in the acetabulum. Unfortunately, there is a tendency for the femur to slip from the socket and for osteo-arthritic changes to occur, particularly in older patients. As a result of this, the patient may have a painful and unstable hip. The author's experience with the Whitman reconstruction operation has not been encouraging. Therefore, in recent years, he began to attempt an arthrodesis of the hip after all other operations had failed. Later he has employed this operation in preference to the reconstruction operation, and in two cases he induced arthrodesis in the hip three months after the fracture when there had been meanwhile complete absorption of the neck. These various procedures are illustrated in Figures 14, 15, 16, 17, and 18.

The roentgenologist will assist the surgeon in his solution of the problem of the treatment of fractures of the neck of the femur by noting degenerative osteo-arthritic

changes in the hip joint present at the time of the fracture, by observing how rapidly the neck undergoes absorption, and by learning to diagnose death of the femoral head. In not more than from 50 to 60 per cent of these fractures can we expect union to occur by the best conservative treatment, and in not more than probably from 70 to 75 per cent by open operation. We must learn to distinguish early those cases which seem to be doomed to non-union from the moment of fracture in order to preserve them from many months and even years of useless treatment, pain and disability. Possibly an arthrodesis of the hip soon after the fracture is the best solution of these cases, but this entire field is still open to study, observation, and research. The roentgenologist and the surgeon must work hand in hand to solve this very important, but very difficult, problem.

The author trusts that this very brief discussion of the possibilities of plastic surgery of the hip may be of interest to the roentgenologist, as well as to the orthopedic surgeon, as both so frequently see the tremendous reconstructive powers of Nature working according to law, both learn to read on the X-ray film the story of what has been taking place within the hip joint, and both must increase their powers of observation in order to solve important problems.

THE ADVANTAGES AND DISADVANTAGES OF SMALL CHAMBER MEASURING INSTRUMENTS¹

ANALYSIS OF BACK-SCATTERED RADIATION

By HOWARD B. HUNT, M.D., Department of Radiology, University of Nebraska, OMAHA

IN the determination and analysis of actual dosage delivered at the surface and within the body, the clinical and laboratory advantages of access and localization, offered by a small chamber measur-

ing instrument, have been utilized for some time by various observers (1, 2, 3). The disadvantages of the small chamber iontoquantimeter have rested in the physical imperfections of the instrument, namely, lack of sensitivity, frequency of leakage, alterations in capacity, and dependence on wave

¹Read at the Annual Meeting of the Radiological Society of North America, at St. Louis, Nov. 30-Dec. 4, 1931

tube stand. This facilitates the manipulation of the instrument for use as an intensimeter, dosimeter, penetrometer, and general laboratory instrument. However, the meter may be readily removed from the

practical factors controlling the intensity of both primary and secondary radiation is an essential in the principles of radiation therapy. Back-scattering may increase the total skin dosage by as much as 65 per cent

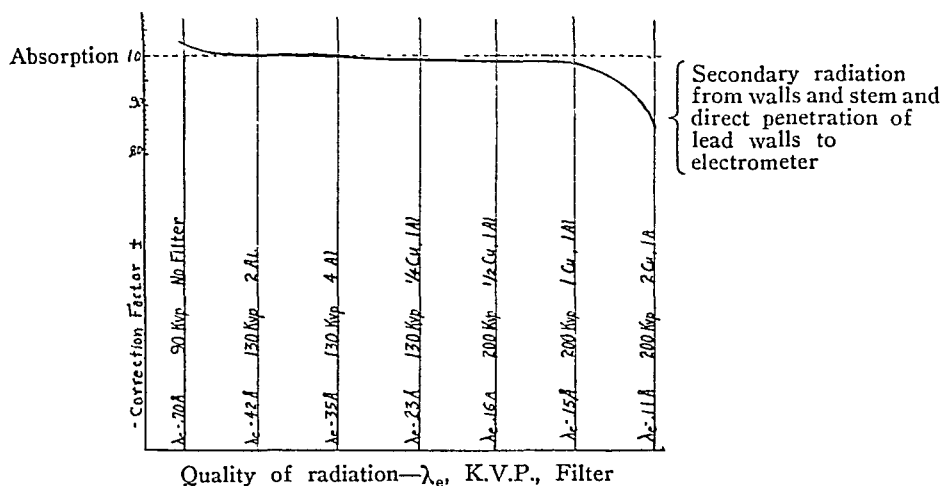


Fig. 2. Calibration of a small chamber iontoquantimeter according to quality. Applicable only to this particular instrument.

stand and used elsewhere in the department, or carried outside for use in the calibration of other X-ray generators.

Through the use of the mounted small chamber iontoquantimeter, it has been possible to record and to analyze observations relating to actual dosage, which would not have been possible with a large chamber instrument. No new findings have been disclosed, but a few fundamental principles (1, 2, 3) have been re-emphasized. The instrument may be readily adapted as a penetrometer through immersion of the chamber within a rice or water phantom, or insertion of it within the body cavities. Placement of the chamber, covered with a thin rubber tube, within the upper vagina will thus provide an index of the radiation delivered to the cervix or ovaries.

By means of the small chamber, radiation delivered at the surface of the body can be analyzed in terms of the primary and back-scattered components. This is of educational value, since an appreciation of the

of the primary radiation, or by as little as 5 per cent, depending on the size and contour of the field, consistency of the region irradiated, and the effective wave length of the incident radiation. In the incident radiation alone analysis shows an increase amounting to 12 per cent, in going from a field 3 cm. to a field 20 cm. in diameter. The increase in the intensity of the back-scattered radiation may equal from 15 to 50 per cent of the corresponding primary radiation. The total skin dosage may, therefore, be increased anywhere from 25 to 60 per cent on increasing the diameter of the field from 3 to 20 cm., depending on the consistency of the region and the individual patient. Further enlargement of the field appears to add only a slight increment to the intensity of the back-scattering.

An analysis of back-scattering from various body areas and various patients shows that the denser and more bulky regions emit the greatest intensity of secondary radiations. The less dense regions, such as the

of air (4, 5), in order that the coefficient of absorption and of scattering may be unaltered from that of air. Furthermore, the density should be equal to that of air in order that the integrated absorption and

though it is not always an instrument with physical precision.²

As shown in the accompanying graph, the excursion of the electrometer indicator for a unit of radiation may differ in the various sections of the scale. The scale may readily be calibrated by constant radiation, such as that from a radium needle or from a stable X-ray circuit. It is seen that an error equal to 6 or 8 per cent may be introduced through reading across only the last five scale divisions. This is usually avoided by beginning the reading at zero. In case the indicator is carried through only the left five spaces of the scale, the uncorrected reading with this instrument may be 3 or 4 per cent below the reading for the entire scale. The probability of error may be lessened by carrying the indicator across at least two-thirds or three-fourths of the scale. The error in reading the scale alone becomes greater than 1 per cent when less than 10 divisions of the scale concerned are traversed.

The calibrations of all ionization chambers are altered by variations in the density of air as altered by changes in temperature and barometric pressure. Alterations of this type, if no correction be made, may readily introduce an error of 5, or even 10, per cent on a warmer summer day in Omaha, according to the tables supplied with the Victoreen "r-meter" from which this graph was compiled. Both large and small chambers are subject to this source of error.

Portability and adaptability of placement are desirable features in a general laboratory dosimeter. The self-contained small chamber instrument can be made to provide both features more satisfactorily than can the large chamber. We have provided adaptable placement and firm support for our "r-meter" by mounting it on an idle

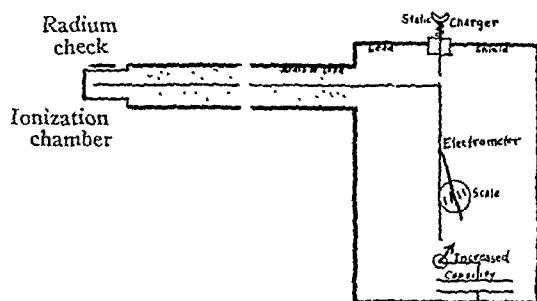


Fig. 1. Small chamber iontoquantimeter.

scattering may be unaltered by the wall. This is feasible only in a true air wall chamber (6) bounded with guard rings and housed in the depths of a bulky system. However, if this is used, the practical advantages of accurate localization and ready access are lost from the small chamber instrument. Glasser (4) and Failla (5, 7) have devised small chamber walls which are relatively independent of wave length over those ranges which are routinely used in roentgen therapy. The approximate correction factors for a Victoreen "r-meter" have been prepared from data supplied by Darnell in a personal communication. The readings are only about 2 or 3 per cent low at 90 K.V.P., through no filter, due to a slight absorption by the wall; they are only about 2 or 3 per cent high at 200 K.V.P., through 1 mm. of copper, due to increased secondary radiation from the walls, rod, and stem. This covers the usual therapy range with a satisfactory degree of accuracy. However, filtration through 2 mm. of copper appears to introduce an appreciable discrepancy, the reading being about 18 per cent higher than with an air wall chamber. Again it is seen that the small chamber instrument is a satisfactory working tool even

²A more recent Victoreen intensimeter of modified design is said to be accurate within 6 per cent for both extremes of wave length, from 30 K.V.P. radiation down through the gamma range (200 K.V.P., 2 mm. Cu gives 0.14 Å. by Röntgen formula, see Fig. 2).

mm. lead hood, open only at the bottom where it was in relation to the back-scattering medium, was placed over the chamber, shielding it against the primary beam. Graded filters of copper and aluminum were inserted in the port opening into the chamber from the back-scattering medium, the effective wave length being calculated by means of the Richtmyer formula (11), from the slope of the absorption curves for both the primary and back-scattered radiation. The measurements relating to the primary radiation were made by reversing the hood, thus directing its port toward the X-ray tube.

The results appeared to be roughly in accord with the refined measurements of Compton (12) by means of the spectrograph (13). A primary effective wave length of 0.15 Ångström was scattered to 0.24; a primary wave length of 0.23 was lengthened to 0.31, and a primary wave length of 0.43 was increased to about 0.50. According to Compton, a single scattering through 180 degrees increases all wave lengths by about 0.05 Ångström. Referring this finding to our determinations, it would appear that many of the back-scattered rays had been scattered twice before reaching the surface. It is significant that scattering tends to produce a relatively much more dampening effect on the very short wave lengths than on the longer wave lengths. This may be somewhat compensated for by more multiple scattering from the shorter primary waves. The experimental errors involved in these observations do not warrant such a discriminating statement, although it is a plausible supposition. Many of the rays scattered from the longer wave lengths are probably so soft as to be absorbed before reaching the surface. Referring this generalization to our previous statements regarding back-scattering, it is obvious that at all times we referred to effective surface scattering, that is, total

scattering minus that portion which was absorbed before reaching the surface.

SUMMARY

1. The small chamber measuring instru-

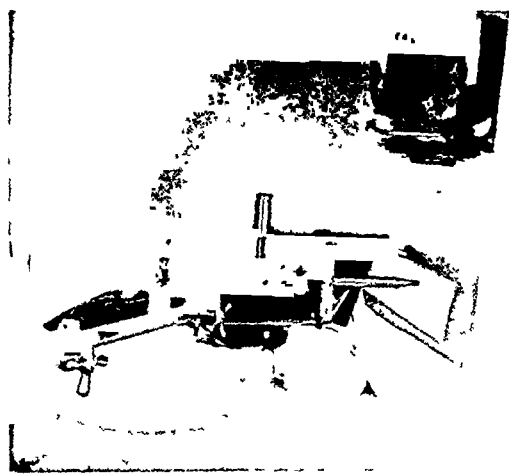


Fig 5.

ment is not an instrument of extreme physical precision.

2. All small chamber instruments should be calibrated by means of a standard air chamber and checked at intervals against a standard source of radiation or a standard chamber.

3. Readings must be corrected for variations in temperature and barometric pressure. They must also be corrected for wave length dependence, electrometer scale variations, and leakage, when these factors become of significant magnitude.

4. The physical disadvantages of the small chamber, such as dependence of wave length, leakage, and relative insensitivity, appear to have been sufficiently minimized in the modern high-grade instrument to allow its use in the usual range of X-ray dosimetry, the error being less than 3 per cent. Significant errors may be introduced when measuring wave lengths shorter than 0.14 or longer than 0.80 Ångström even with a good commercial instrument.

chest and gas-distended bowel, and less bulky structures—the extremities, for instance—emit proportionately less secondary radiation. For example, the buttocks may return back-scattered radiation having an

to 40 per cent of the primary intensity. It is increased from an intensity equal to 40 per cent of the primary to an intensity equal to 50 per cent of the primary radiation on changing from filtration through 1 mm. of

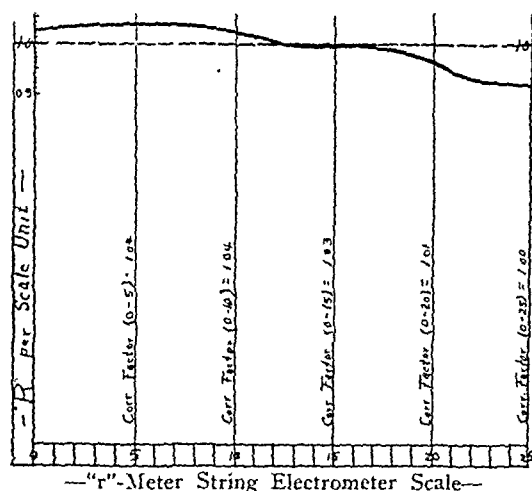


Fig. 3. Calibration of an electrometer scale by γ -radiation.

intensity equal to 40 or 60 per cent of the primary, as compared with 30 or 40 per cent from the chest, and 20 or 30 per cent from the extremities, even though there be no variation in field size. Different patients give variations in intensity of back-scattering from the same region, which may alter the total dosage by 15 or 20 per cent.

Significant determinations regarding back-scattering can also be made from paraffin phantoms. A graph presents measurements of effective back-scattering excited by primary beams of various effective wave lengths. The wave lengths were estimated from the slope of their logarithmic absorption curves by means of Richtmyer's formula (11):

$$\mu_{\lambda}/\rho = A\lambda^3 + K$$

The wave lengths for the no-filter determinations are necessarily only roughly approximated. On changing from unfiltered to filtered radiation, it is seen that the intensity of back-scattering is increased from 20

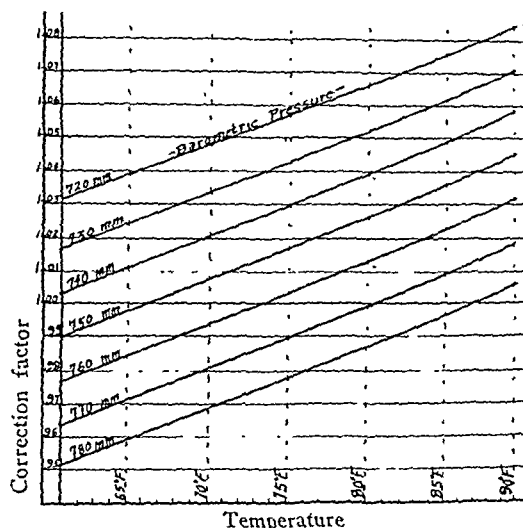


Fig. 4. Calibration of iontoquantimeter according to barometric pressure and temperature (adapted from Victoreen No. 218 chart).

aluminum to filtration through 1.4 mm. of copper. It is probable that the decrease in surface back-scattering observed with a longer primary wave length results chiefly from the elimination of an increasingly large portion of it within the scattering medium. The denser the scattering medium, the more obvious becomes the effect of wave length on the intensity of surface back-scattering (12). Observations regarding the relative wave lengths of primary and secondary radiation may explain the manner in which a variable portion of the secondary radiation can be trapped within the scattering medium.³

It was possible to estimate the comparative effective wave lengths of primary radiations and the back-scattered radiation excited by it from a paraffin phantom. A 4

³Paradoxically, back-scattering is definitely diminished with wave lengths shorter than 0.23 Angstrom (see plot points in Fig. 7), and becomes reduced to 30 or 35 per cent at 200 K.V.P., 2 mm. Cu.

timeter. The secondary rays were lengthened by from 0.07 to 0.09 Ångström, suggesting multiple scattering of many rays.

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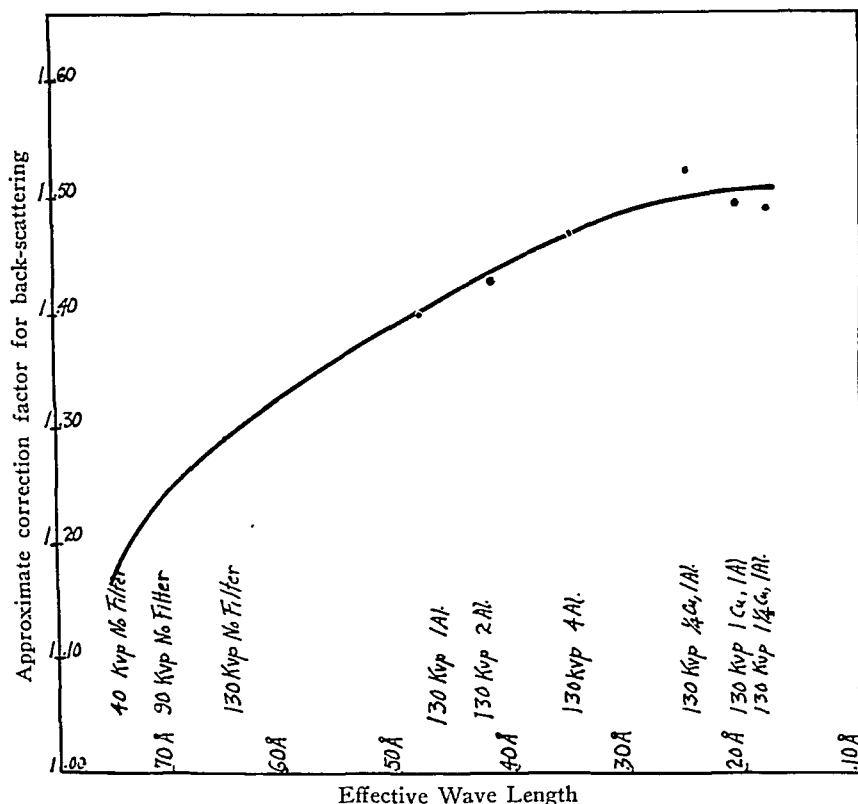


Fig. 7. Relation between intensity of back-scattering from parowax phantom and quality of incident primary radiation. Field = 20 square centimeters.

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5. Distortion of readings for short wave lengths makes it difficult to estimate accurately effective wave lengths shorter than 0.14 Ångström by means of our small chamber.

9. In view of these many variables, it appears fallacious to calibrate r output with one size cone and one back-scattering medium, and to apply this one dosage value indiscriminately to all regions with all sizes

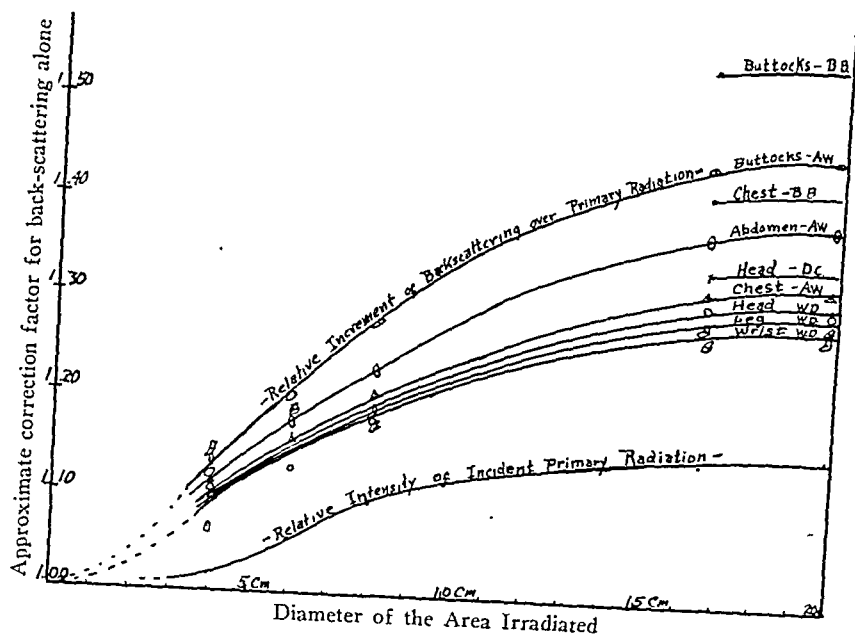


Fig. 6. Relation between intensity of back-scattering and the size and consistency of the area irradiated. $\lambda = 0.23 \text{ Å}$, distance ≈ 42 centimeters.

6. The small chamber offers the advantage of accurate local placement, enabling one to measure skin dosage and estimate depth intensities.

7. It is a desirable teaching instrument, providing a means of analyzing the factors controlling intensity and quality of secondary, as well as primary, radiation.

8. Analysis shows that back-scattered radiation may increase the total skin dosage by from 5 to 65 per cent, depending on the size and contour of the field, region of the body, consistency of the patient, and the effective wave length. The relation of these factors to the intensity of back-scattering is presented in graphs.

of fields. It is more honest to measure routinely the dosage in air and estimate the total biologic dosage, or to make direct intensity delivery measurements at the point in question with the small chamber iontoquantimeter.

10. Alterations in estimated dosage by from 10 to 50 per cent, due to variations in scattering, submerge an error of 2 or 3 per cent, which may be involved in the measurement of that dosage by the small chamber instrument.

11. The relative effective wave lengths of primary and secondary radiation were estimated by means of absorption curves made with the small chamber iontoquan-

volved. In the former, sarcoma develops in the tissue of the endometrium.

Carcinoma of the uterus has three distinct fields of development:

1. The absolute end of the cervix in an old infected scar or tear. This can easily be seen vaginally.
2. The cervix proper, extending from the external os up through the vagina to the internal os.
3. The uterine walls, beginning in the mucosa or endometrium, from the internal os to the fundus of the uterus.

Histologically there are two kinds: cylindric-cell, or adenocarcinoma, and squamous-cell carcinoma. Cylindric-cell carcinoma of the endocervix originates in the cell covering the endocervix or in the cells of the cervical glands. Carcinoma of the body, which is nearly always of the cylindric-cell form, originates, as does that of the cervical canal, either in the surface or in the glandular epithelium. Of the different anatomic varieties, carcinoma of the cervix is by far the most frequent. This structure is involved in approximately 90 per cent of all cases. Squamous-cell cancer of the cervix nearly always develops in the epithelial covering of the vaginal portion. Its origin is more probably the result of metaplasia of the surface epithelium.

In cancer of the cervix, the growth appears as a small, hard, indurated nodule in the wall of either the anterior or posterior lip—a more or less diffuse or papillary growth. There are really few malignancies that have their origin in the uterine body proper. Sarcoma of the uterine body does occur, but it is rare. Carcinoma of the cervix is easily accessible and is readily seen and recognized. Inspect the cervix for pre-cancerous lesions. A nodule circumscribed and indurated on the cervix, a deep ulceration which bleeds easily, should always be viewed with suspicion. A cauliflower growth on the cervix is readily recognized as a cancerous growth. A cervix that has long been assaulted by bacterial invasion

from the intestinal tract will certainly undergo degeneration frequently, whether the patient has been pregnant or not. Every cervix is a field for cancerous degeneration. When the lymphatics are disabled by foreign poisons, they are easy victims for the cancer cell, and it is through these channels that the malignant cell travels. Pain in cervical cancer is the last of numerous signs of the destructive process going on. Digital examination of the endocervix is not enough: the cervix should be palpated between the index finger and thumb throughout its entire length. Tears frequently take place along the cervical canal with no visible lesion of the endocervix, these tears constituting sites of scar tissue with infection, small cysts, and cervical myomas. To look at a cervix and say there is no tear is inexcusable. These infections within the canal will produce an endometritis, with complete fibrous degeneration of the uterus. All unrepaired tears heal with infection and leave scar tissue. After expert surgical repair, none of these conditions will be found.

The common cancers, such as epithelioma, medullary cancer of the cervix, and scirrhus cancer of the breast, do not start as cancer. Their very beginning dates back to some small pathologic lesion, possibly a mastitis, a tight cyst in the breast, a sub-mucous myoma, a severe, or even a slight, laceration of the cervix. The effect of bacterial toxins upon lesions is the causative factor; therefore, in order to prevent cancer, we must begin at the beginning of the contributing cause.

Adenocarcinoma of the uterus arises in the mucous membrane of the uterine cavity. It is a rare condition in young women, but is rather common in women advanced in years and those who have not borne children. It is most readily cured by dilating the cervix and applying 50 mg. radium for 24 hours to the uterine cavity. In uterine cancer, glandular involvement occurs much later than in any other portion of the body.

PREVENTION AND TREATMENT IN CERVICAL UTERINE CANCER¹

By FRANKLIN I. SHROYER, M.D., DAYTON, OHIO

TO-DAY, the most important factor in our fight against cancer is being overlooked by some. There is a clear principle that runs through all the various etiologic factors, namely, that thermal, chemical, and mechanical irritations play a part in cancerous development, and chronic and subacute infections are preventable in all. The question is at once asked, "Why, then, are there not more cancers, since almost every person has had some part of the body exposed to irritation, and since infection of various forms is present in almost every person's body?"

This question is readily answered. Fortunately, the greater number of persons have a body resistance which is too great to allow cancer cells to develop, while there is no doubt but that a certain number of us have a natural immunity. The fact that not all infections lead to cancer is puzzling to some students, but it need not be so, because certain persons have the resistive powers within their cells to conquer the infection and destroy it.

Immediate operation should never be performed upon any malignant condition. The unfortunate individuals should be put upon a detoxicating diet, with colonic irrigations of two quarts of hot sodium bicarbonate solution morning and evening, until there is a noticeable softening of the mass and a reduction of the surrounding inflammation. About two weeks of such treatment will give the desired result. During the detoxicating régime, the surrounding lymphatics should be thoroughly irradiated. The radium should be sufficiently screened to prevent an erythema.

The mistaken idea that the etiology of

cancer must date back to some specific thing has been a great drawback to the proper understanding of the subject. There are no facts known to medical science which justify this idea. Evidence pointing to the contrary furnishes us with a basis upon which we are able to formulate methods of prevention and cure.

The most important factor in the proliferation of cells cannot be other than the presence of low-grade micro-organisms of pathogenic origin. Most of the chronic pains and aches which afflict the human body are caused by a localization of infection. These same micro-organisms, by their incessant production of poisons within the body, are the cause of old age. Carcinoma, sarcoma developing in the uterus, hypernephroma developing in the upper pole of the kidney, carcinoma developing in the breast, gliomas in the brain—all have etiologic factors peculiar to the organ in which they are located. It is, therefore, logical to believe that the irritating factors which cause the one certainly are similar to those causing the other. Cancer, or cell proliferation, develops in an area of lowered resistance at a point at which insult to the tissues has occurred. Thus the germ finds a more favorable culture medium and there is consequent irritation.

Malignant tumors of any organ are divided into connective and epithelial tissue cell types. Of the epithelia, there are two varieties, carcinoma and epithelioma. Carcinoma may develop in the mucous membrane between the uterine cervix and fundus, in the surface epithelium, or in the glands of the cervix. The two types of connective tissue malignancy are sarcoma and epithelioma. In the latter, epithelial cells of the lymph channels and blood vessels become in-

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

volved. In the former, sarcoma develops in the tissue of the endometrium.

Carcinoma of the uterus has three distinct fields of development:

1. The absolute end of the cervix in an old infected scar or tear. This can easily be seen vaginally.
2. The cervix proper, extending from the external os up through the vagina to the internal os.
3. The uterine walls, beginning in the mucosa or endometrium, from the internal os to the fundus of the uterus.

Histologically there are two kinds: cylindric-cell, or adenocarcinoma, and squamous-cell carcinoma. Cylindric-cell carcinoma of the endocervix originates in the cell covering the endocervix or in the cells of the cervical glands. Carcinoma of the body, which is nearly always of the cylindric-cell form, originates, as does that of the cervical canal, either in the surface or in the glandular epithelium. Of the different anatomic varieties, carcinoma of the cervix is by far the most frequent. This structure is involved in approximately 90 per cent of all cases. Squamous-cell cancer of the cervix nearly always develops in the epithelial covering of the vaginal portion. Its origin is more probably the result of metaplasia of the surface epithelium.

In cancer of the cervix, the growth appears as a small, hard, indurated nodule in the wall of either the anterior or posterior lip—a more or less diffuse or papillary growth. There are really few malignancies that have their origin in the uterine body proper. Sarcoma of the uterine body does occur, but it is rare. Carcinoma of the cervix is easily accessible and is readily seen and recognized. Inspect the cervix for pre-cancerous lesions. A nodule circumscribed and indurated on the cervix, a deep ulceration which bleeds easily, should always be viewed with suspicion. A cauliflower growth on the cervix is readily recognized as a cancerous growth. A cervix that has long been assaulted by bacterial invasion

from the intestinal tract will certainly undergo degeneration frequently, whether the patient has been pregnant or not. Every cervix is a field for cancerous degeneration. When the lymphatics are disabled by foreign poisons, they are easy victims for the cancer cell, and it is through these channels that the malignant cell travels. Pain in cervical cancer is the last of numerous signs of the destructive process going on. Digital examination of the endocervix is not enough: the cervix should be palpated between the index finger and thumb throughout its entire length. Tears frequently take place along the cervical canal with no visible lesion of the endocervix, these tears constituting sites of scar tissue with infection, small cysts, and cervical myomas. To look at a cervix and say there is no tear is inexcusable. These infections within the canal will produce an endometritis, with complete fibrous degeneration of the uterus. All un-repaired tears heal with infection and leave scar tissue. After expert surgical repair, none of these conditions will be found.

The common cancers, such as epithelioma, medullary cancer of the cervix, and scirrhus cancer of the breast, do not start as cancer. Their very beginning dates back to some small pathologic lesion, possibly a mastitis, a tight cyst in the breast, a sub-mucous myoma, a severe, or even a slight, laceration of the cervix. The effect of bacterial toxins upon lesions is the causative factor; therefore, in order to prevent cancer, we must begin at the beginning of the contributing cause.

Adenocarcinoma of the uterus arises in the mucous membrane of the uterine cavity. It is a rare condition in young women, but is rather common in women advanced in years and those who have not borne children. It is most readily cured by dilating the cervix and applying 50 mg. radium for 24 hours to the uterine cavity. In uterine cancer, glandular involvement occurs much later than in any other portion of the body.

PREVENTION AND TREATMENT IN CERVICAL UTERINE CANCER¹

By FRANKLIN I. SHROYER, M.D., DAYTON, OHIO

TO-DAY, the most important factor in our fight against cancer is being overlooked by some. There is a clear principle that runs through all the various etiologic factors, namely, that thermal, chemical, and mechanical irritations play a part in cancerous development, and chronic and subacute infections are preventable in all. The question is at once asked, "Why, then, are there not more cancers, since almost every person has had some part of the body exposed to irritation, and since infection of various forms is present in almost every person's body?"

This question is readily answered. Fortunately, the greater number of persons have a body resistance which is too great to allow cancer cells to develop, while there is no doubt but that a certain number of us have a natural immunity. The fact that not all infections lead to cancer is puzzling to some students, but it need not be so, because certain persons have the resistive powers within their cells to conquer the infection and destroy it.

Immediate operation should never be performed upon any malignant condition. The unfortunate individuals should be put upon a detoxicating diet, with colonic irrigations of two quarts of hot sodium bicarbonate solution morning and evening, until there is a noticeable softening of the mass and a reduction of the surrounding inflammation. About two weeks of such treatment will give the desired result. During the detoxicating régime, the surrounding lymphatics should be thoroughly irradiated. The radium should be sufficiently screened to prevent an erythema.

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cancer must date back to some specific thing has been a great drawback to the proper understanding of the subject. There are no facts known to medical science which justify this idea. Evidence pointing to the contrary furnishes us with a basis upon which we are able to formulate methods of prevention and cure.

The most important factor in the proliferation of cells cannot be other than the presence of low-grade micro-organisms of pathogenic origin. Most of the chronic pains and aches which afflict the human body are caused by a localization of infection. These same micro-organisms, by their incessant production of poisons within the body, are the cause of old age. Carcinoma, sarcoma developing in the uterus, hypernephroma developing in the upper pole of the kidney, carcinoma developing in the breast, gliomas in the brain—all have etiologic factors peculiar to the organ in which they are located. It is, therefore, logical to believe that the irritating factors which cause the one certainly are similar to those causing the other. Cancer, or cell proliferation, develops in an area of lowered resistance at a point at which insult to the tissues has occurred. Thus the germ finds a more favorable culture medium and there is consequent irritation.

Malignant tumors of any organ are divided into connective and epithelial tissue cell types. Of the epithelia, there are two varieties, carcinoma and epithelioma. Carcinoma may develop in the mucous membrane between the uterine cervix and fundus, in the surface epithelium, or in the glands of the cervix. The two types of connective tissue malignancy are sarcoma and epithelioma. In the latter, epithelial cells of the lymph channels and blood vessels become in-

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mental medical science who denied the precancerous stage in dealing with the disease."

To remove a part of the uterus and leave the cervix is inviting disaster to the patient in later life. If the body of the uterus is diseased enough to necessitate removal, then the cervix also is, excepting in the case of a uterus that has never been impregnated and not myomatous. Adenocarcinoma of the uterus is rarer than cervical cancer; it grows more slowly and has a tendency to remain restricted to the uterine body. This form of cancer occurs in later life, restricting itself because of the beginning atrophy of the uterus and pelvic lymphatics in women about the age of fifty years. "The Journal of Cancer Research" recently stated that the incidence of the development of cancer on the cervical stump after subtotal hysterectomy is more than 4 per cent. Dr. Robert Monad, of Paris, states that cancer of the cervical stump began to be noticed more frequently when total hysterectomy was replaced by subtotal hysterectomy. The apparent rarity of this condition may be estimated from the fact that, up until 1921, only 80 cases had been reported in the French literature. Between 1920 and 1931, 180 cases of carcinomas of the cervical stump were treated by radium in six different cancer centers in Paris, and, during this period, 300 cases were recorded in the French literature. The incidence of carcinoma affecting the cervical stump after subtotal hysterectomy is reported as varying between 5 and 6 per cent. This is distinctly higher than the incidence of carcinoma of the cervix. From the Curie Institute, it is reported that five out of six cases of carcinoma of the cervical stump, appearing within one year after the operation, were glandular in type. These observations suggest that the glandular carcinomas appearing so soon after operation are actually recurrences of the previously indicated malignant lesions of the uterine mucosa. The co-existence of myoma and carcinoma is far from

exceptional. Every surgeon should keep this in mind when operating for uterine myoma. Monad agrees with Faure that, for myoma of the uterus in women during the menopause, total hysterectomy is the method of choice. Monad and Moreston, of Paris, both agree that the only way to perfect subtotal hysterectomy is to perform a total hysterectomy: the various modifications of subtotal hysterectomy are not satisfactory. If total hysterectomy is not advisable, then 50 mg. radium are applied to the uterine cavity and the cervix, screened with 2 mm. brass and 1 mm. hard rubber, for 24 hours.

The prognosis in carcinoma of the cervical stump is more grave than it is in carcinoma of the cervix in which the uterus has not been removed. Surgical treatment, according to the Curie Institute, Paris, has failed, and radium is the method of choice. The opinion of all leading authorities, as compiled by the Department of Cancer Research at Columbia University, is that the sure prophylactic measure against carcinoma of the cervical stump is to increase the practice of total hysterectomy. The number of operative deaths from the more radical procedure will be less than that from carcinoma of the cervix. From a therapeutic standpoint, the treatment of choice is radiotherapy; therefore, it is being taught, and it is the opinion of men of broad experience, that cancer is preventable and curable. To remove a part of the uterus and leave a cervix is distinctly poor judgment; even to enucleate a cervix in the procedure of total hysterectomy is cheating the patient. The mortality rate from total hysterectomy is no greater than that from subtotal hysterectomy, if blood loss is controlled. Ligatures should take the place of too many hemostats, since the latter cause bruising. It is not necessary to use more than 10 or 12, at the very most.

In the breast, an adenoma is not cancerous, but it is surely precancerous. Ade-

A complete physical examination is always essential, as the following case will illustrate.

Mrs. K. consulted me six years ago because she was always tired, irritable, nervous, bloated after meals, and constipated. I examined her thoroughly and found that there was a bilateral tear of the cervix, a boggy uterus, and a leukorrheal discharge. I advised her to have a cervical repair and rid the uterus of infection, as this ought to cure her completely. She did not have this done at the time. Four years later, an osteopath sent this same patient to me again. By this time she was sorry she had not taken the advice in the first place. During the interval she had consulted three or four doctors and each one told her I was wrong—that she was having no trouble from the tear—that it was healed. I wish to state again that “the old scar in a healed cervix is just as dangerous as a new infected tear, because it was infected before it was healed.” She had been treated for indigestion, tired heart, and had received four weeks’ treatment in a hospital for nervous breakdown. Several weeks after hospitalization, she had moved to the country and was treated for rheumatism for a period of one year. At last she sought osteopathic treatments. Shortly after this, following a severe hemorrhage, she was referred again to me. A large cauliflower growth had completely involved the cervix. The cervical tear and scar could no longer be seen.

The woman died four months later with medullary carcinoma, at the age of 42 years, all because of inefficient diagnosis and neglect of early treatment. There is no excuse for such an error in diagnosis. “We are all too afraid of offending one another.” This patient was treated for all the symptoms and not once for the underlying cause. You will agree that, if we make a mistake and are told about it, it will not happen again.

Every woman should be examined by a competent gynecologist, because he will be

able to recognize a cervical lesion and to institute proper treatment for childbirth injuries, if such exist. Obstetricians are learning to direct their patients to return for further examinations, but these should be made at the end of six months, or one year, instead of three or four weeks after childbirth. Any cervix presenting a wide open mouth is diseased; any cervix that is cystic and swollen is diseased. All uteri larger than normal are infected and subinvolved, and all subinvolutions are due to infection at childbirth or abortion. Cervical infections with subinvolution of the uterus will make nervous wrecks out of their hosts. Every infected cervix and uterus treated and cured is a precancerous lesion eradicated.

Cancer patients should all be grouped together and intensively studied. There has been, and still is, a tendency to overemphasize operations. A few days will not make much difference in the prognosis of a cancer. Once well developed, it is the most difficult disease to cure, but it can be cured, if it is seen in its beginning. The physician must not be careless or indifferent in making an examination, and the examination is not complete unless every organ has been checked. The physician must be able to correlate the different pictures presented by disease and he must also be able to visualize disease.

Quigley² says: “One reason why medical men have made so little progress with cancer is that they have paid so little attention to the conditions that lead up to the development of cancer. The men who deny or reject the term ‘precancerous’ are those trained on only one side of the cancer question. They are either laboratory men without clinical experience or medical men without laboratory experience and with little knowledge of fundamental medical science. I have never known a medical man of wide experience and proper knowledge of funda-

²Quigley, D. T.: *The Conquest of Cancer by Radium and Other Methods*. F. A. Davis Company, Philadelphia, 1929.

tion of scar tissue; but all should be repaired before the menopausal change.

Cancer is much more easily prevented than cured. It is absolutely curable in its early stages. Swanberg, after a broad survey of the methods of treatment of cervical cancer, is decidedly in favor of radiation therapy. The technic of the Radium Institute, Paris, with its use of relatively small amounts of radium for long periods, high filtration, and multiple centers, is accepted as superior to the American method of concentrated dosage. The results showed 30 per cent of cases cured for five years (Regaud), a figure which Swanberg believes can be approximated by the conscientious physician who is properly prepared to treat cervical cancer by radiation. Radium is now recognized definitely in the fight against cancer through the work of leading surgeons and clinic groups. Some of the advantages advocated for radium are: the absence of fear in the patient as a result of early treatment, low mortality, its efficacy in both operable and inoperable cases and the constant advancement and improvement in technic, while surgery is taught and practised as standardized procedures. A statistical report of various authorities (Zachell, Lindwahl, Adler, Kroening, Gauss, and Giescke) shows that the number of their cures was doubled by routine post-operative irradiation in comparison with the number of cures achieved by surgery alone. The value of post-operative radiation of the ovary and breast, for example, has been demonstrated by Seitz and others.

It is agreed that early diagnosis is the most important point in the treatment of cancer. Another important factor in our battle against such a worthy foe is to clear the body of any infected, irritated area, thus preventing a cancerous growth. Just such a thing is possible. I performed a colostomy on a patient, 55 years of age, who was suffering with cancer of the rec-

tum. Six years earlier, I had advised a cervical repair and radium to the uterine cavity, or a panhysterectomy, but all treatment had been refused and the patient was treated for "liver disorder." She could not see the connection between the two. Six months before this report she had pain in her back and some vaginal bleeding. The cervix was fixed, with complete degeneration. The pathologic report was advanced medullary carcinoma. Radium treatment to the cervix and uterine cavity was given, after which the cervix healed perfectly. The rectum was also involved, and colostomy was performed and radium applied. If the cervix and body of the uterus had been removed, or the former repaired and radium applied to the uterine cavity to kill infection, the patient certainly would not have suffered later from an extension to the rectum.

Never perform a total or subtotal hysterectomy for menorrhagia: radium will cure these cases; it not only destroys cancer cells but kills the infection present. If hemorrhage is not corrected, then operation is in order after several radiations, and few patients will die following the operation. I irradiate all myomas and fibroids except those which are pedunculated and calcified. Afterwards, if necessary, I operate—in two or three months. I have to report almost no surgical deaths. In removing the cervix and the body of the uterus, I loosen the cervix vaginally with actual cautery throughout the length, with gauze on the index finger, completing the operation by the suprapubic route, with only four or five hemostats.

SUMMARY

The problem that confronts us, then, is how to prevent a malignant transformation of the normal cell, and, once malignant transformation has set in, how to destroy the cell. If by some means we can determine the accurate quantitative measure-

noma grows slowly within its capsule or sac. One reason for the peculiar susceptibility of the female breast tissue to cancer is the fact that, from puberty to old age, the epithelium is never at rest. Hypertrophy takes place at every menstrual period. Between periods, the epithelium is either growing, as the period appears, or shrinking, following menstruation. Every month the epithelial cells are stimulated by hormone growth. Infection is the most prominent precancerous condition in the lactating breast, and injury is the most prominent in the non-lactating breast. These two etiologic factors work together in either case, both trauma and infection being present. Infection and injury will produce scars and interfere with drainage, so that stagnation occurs. Stagnation in any part of the body leads to loss of vitality, causes illness, and, finally, death to the part affected. Food must be carried to each and every cell. The incoming food material is carried to the arteries, and the outgoing waste material is carried away by the veins and lymphatics. The microscopic finding of basement membrane broken through by epithelial cells does not mean just cancer—it means advanced cancer. The average pathologist is trained to recognize cancer only after basement membrane has been broken through. He, therefore, labels many cases benign, which in reality are malignant. He misses all the early stages of the disease. A lump in the breast of an old or middle-aged woman should always be considered cancer until it can be proved otherwise. The woman who, at the age of 25, carries a more or less benign adenoma in her breast, carries, if she does not have it removed before the age of 35, a cancer. General practitioners and surgeons must, therefore, correlate symptoms, thereby visualizing the outcome of an apparently harmless condition. When this method is followed, the death rate from cancer will surely decrease.

In removing a breast, I make a wide ex-

cision, remove supra- and infraclavicular and axillary glands, then transplant a flap from the other breast over the area of removed breast. Results are excellent and no skin grafting is necessary. The treatment of cancer of the breast would be effective if early irradiation were instituted. Post-operative radiation has, no doubt, added from 8 to 12 per cent to the five-year cure of all cases operated upon. Radiation therapy should always be administered by one who is competent to do so in a scientific manner, with proper equipment. I have always advocated pre-operative radiation in any suspicious growth. I have also been a profound believer in repeated doses over short periods of time. I am pleased to note that Forssell, of Stockholm, to-day advocates similar treatment. In cancer of the breast, operation is not undertaken until four or five weeks after the last radiation. One, two, or three post-operative treatments with radiation are given at intervals of from six to eight months.

In inoperable cases of carcinoma of the uterus, radium offers a method comparable to surgery. Radium offers, too, the possibility of a cure or definite palliation in some inoperable cases. When there is any doubt as to the extent of the disease, use radium, then operate in two or three weeks if you must. This is the treatment of choice. In the female, 30 per cent of all cancerous growths involve the uterus, and 90 per cent of uterine cancer has its origin in the cervix. Old cervical lacerations cause 95 per cent of the cervical cancers. If we as a profession imparted to our patients knowledge of the danger from an old cervical tear and other irritations, and were able to see to it that the advice was acted upon, 90 per cent of all our cancer problems would be solved. If cervical lacerations are not repaired, they should be treated by various well known methods to keep down infection and irritation, and to prevent further forma-

particularly in children. In the Bronchoscopic Clinics of Philadelphia, over 2,700 cases of foreign bodies in the air and food passages have been recorded. In addition to these, reports of large series of cases have been published by bronchoscopists from other parts of the country. Statistics such as these should definitely remove foreign body accidents from the category of rare diseases and medical curiosities.

SYMPTOMATOLOGY

A careful inquiry into the beginning of the patient's illness will often suggest the diagnosis. In no branch of medicine is a carefully elicited history more important. *Initial symptoms* of coughing, choking, and gagging, and at times cyanosis, are very significant and should always suggest foreign body. If the child had something in its mouth at the time that these were noted, the case should be considered as one of foreign body until proven negative. The development of respiratory symptoms immediately following an operation on the upper air and food passages is suggestive. The occurrence of difficulty with swallowing or regurgitation in a child should call for prompt roentgen study to rule out esophageal disease and particularly foreign body. Failure to make inquiries into the history *with foreign body in mind* or to evaluate properly statements made by the patient or family regarding the onset of the illness has probably contributed more to the number of overlooked foreign body cases than any other single factor. While a foreign body may be aspirated or swallowed without producing these initial symptoms, in a vast majority of the cases there is *something* to point to foreign body as a possible etiologic factor.

In aspirated foreign bodies, the development of symptoms and signs following the initial accident depends upon many factors. The most valuable, and often the first symptom to be observed, is the asthmatoïd

wheeze described by Jackson. Frequently this will develop immediately after the initial paroxysm; it may be the only symptom. It should always be regarded with suspicion. If it occurs after the initial symptoms, it can be considered pathognomonic of foreign body and should not be interpreted as a manifestation of suddenly acquired asthma.

The size of the object and its ability to cause bronchial obstruction are important. Foreign bodies such as common pins, which usually gravitate to a small bronchial subdivision, may give rise to no symptoms and few signs. The *symptomless interval* is misleading, for it commonly is interpreted as an indication that the foreign body, if present, has been swallowed and should no longer be a source of anxiety.

If the object is of large size it may produce partial or complete bronchial obstruction. Certain foreign bodies, such as peanuts, often produce partial obstruction and give rise to the phenomenon described as obstructive emphysema. Rounded objects, notably beans, which promptly swell in the presence of moisture, usually block a bronchus completely, producing obstructive atelectasis. Obstructive emphysema, indicating *partial bronchial obstruction*, and obstructive atelectasis, resulting from *complete bronchial obstruction*, are very readily recognized by the roentgenologist. These may be produced by any foreign body so shaped that it will cause a bronchial block of sufficient degree. It must also be recalled that these phenomena are commonly observed in endobronchial neoplasms, extra-bronchial lesions producing compression stenosis, and in many other conditions.

Vegetal foreign bodies, by reason of certain components, set up a severe laryngo-tracheobronchitis in young children. The peanut, which is the most commonly observed intruder in this group, produces a reaction which has been designated as arachidic bronchitis. The physical signs in

ments of the activating and depressor substances, or different cellular elements and body fluids, we may then at least feel that our feet are firmly planted on the road to a fuller knowledge in order to arrive at the origin of the entire cancer problem. This problem can be solved by making gynecologic examinations, and by always looking at the cervix as well as palpating it. Put all patients on a detoxicating diet of fruits, vegetables, and buttermilk, and give hot sodium bicarbonate enemas daily. This will clear the colon of all infection. A soapsuds enema has no place as a therapeutic agent. The majority of women complaining of nervous disorders, general tiredness, backache, mental irritations, leukorrheal discharge, constipation, and palpitation of the heart are affected by toxic poisons, generally from the pelvic organs. If you are a specialist, remember there are other organs besides the one in which you specialize. These patients

usually have a congested liver and will feel better at once if given calomel followed by epsom salts next morning. All cancer patients present these complaints and frequently they admit that they have been getting worse each year. I have seen patients who have been treated for heart disease for several months. When they are examined (and thyroid disease is absent), often the real underlying cause has proved to be a lacerated cervix with accompanying gallstones. Why should not these patients develop cancer with such bombardment of bacterial and chemical toxins? Clear up the intestinal tract with proper foods; remove all points of infection and irritation. Do not wait and watch a condition to see what the outcome will be, but institute the most scientific treatment available. By doing so, you will be able to prevent many an individual from becoming a victim of cancer.

FOREIGN BODY ACCIDENTS IN CHILDREN¹

DIAGNOSIS AND TREATMENT

By LOUIS H. CLERF, M.D., Professor of Bronchoscopy and Esophagoscopy,
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A MORE general use of the roentgen ray in diagnosis of pulmonary and esophageal diseases has provided a positive aid to diagnosis and has greatly contributed to early and prompt recognition of foreign bodies in the air and food passages. The accumulation of clinical observations and pathologic data in foreign body cases and the correlation of these findings by the internist, the roentgenologist, and the bronchoscopist have led to the recognition of fairly definite clinical pictures and roentgen findings. Notable among the contributors in their respective fields are McCrae, Manges, and Jackson.

Although papers setting forth the symptomatology, diagnosis, and treatment of foreign bodies have frequently appeared in medical literature, the subject continues to be of sufficient importance to merit further emphasis. Difficulties in diagnosis are rarely encountered if it is known that a foreign body has either been aspirated or swallowed and appropriate studies are carried out to bring the case to a conclusion. The greatest obstacle in diagnosis lies in our failure to think of a foreign body as a possible etiologic factor. The fact that foreign bodies are so often overlooked should make us become "foreign body-minded."

It seems superfluous to emphasize the frequent occurrence of foreign body accidents,

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particularly in children. In the Bronchoscopic Clinics of Philadelphia, over 2,700 cases of foreign bodies in the air and food passages have been recorded. In addition to these, reports of large series of cases have been published by bronchoscopists from other parts of the country. Statistics such as these should definitely remove foreign body accidents from the category of rare diseases and medical curiosities.

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wheeze described by Jackson. Frequently this will develop immediately after the initial paroxysm; it may be the only symptom. It should always be regarded with suspicion. If it occurs after the initial symptoms, it can be considered pathognomonic of foreign body and should not be interpreted as a manifestation of suddenly acquired asthma.

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these cases may be confusing on account of the secretions present. The presence of bronchial obstruction is important and little difficulty should be encountered in its recognition by physical examination. Obviously, its cause cannot always be determined except by direct examination. Migratory foreign bodies are readily recognized if the characteristic audible slap and palpatory thud can be elicited. A widespread inflammatory reaction is frequently present, and signs of unilateral bronchial obstruction often cannot be elicited. It is important in these cases to look for signs of bilateral obstructive emphysema, the presence of which is indicative of laryngeal or tracheal obstruction.

Cough is a common symptom but one not peculiar to foreign body cases; in certain instances it is suggestive of bronchial irritation. In migratory foreign bodies, it may be paroxysmal. There is often a tendency for the patient to attempt to suppress the cough.

The common symptoms of esophageal foreign body are disturbances in the swallowing function. In the young, these are often difficult to elicit unless there is regurgitation. In larger children, solid and soft foods cannot be swallowed. It must be recalled that respiratory tract symptoms may be present in esophageal foreign body cases. These result from overflow of secretion into the airway, or the presence of a fistulous communication between the esophagus and the trachea.

In cases of foreign bodies that have entered the stomach, there usually are no symptoms present.

DIAGNOSIS

A complete history is important. The occurrence of symptoms of cough, choking, or gagging should always be suggestive. The presence of a wheeze, heard at the open mouth, particularly at the end of expiration, is indicative of something in the air pas-

sages. A complete physical examination should be made, bronchial obstruction being borne in mind. Whenever possible, these investigations should precede the roentgen studies. The roentgen examination should be complete and, in the absence of any evidence to suggest a foreign body in the air passages, the entire alimentary canal, from the nasopharynx to the tuberosities of the ischium, should be studied. In cases of metallic foreign bodies, there should be no difficulty in recognition provided proper roentgenograms have been made, however, errors in interpretation of the findings may occur. At times, a coin, or safety pin, in the esophagus is reported to be in the trachea. It should be remembered that, as a rule, flat foreign bodies such as coins, discs, open safety pins, and similar objects in the airway, are found with their greatest diameter in the sagittal plane, and, if the foreign body is in the esophagus, in the coronal plane. In non-opaque foreign bodies in the airway, it is important to observe the patient under the fluoroscope and to make roentgenograms at the end of inspiration and of expiration. Obstructive emphysema usually cannot be detected if studies are made only at the end of full inspiration.

Buttons and bones are among the more common esophageal foreign bodies found in children that may be non-opaque to the roentgen ray. In these, and in similar objects, it may be necessary to use a bismuth or barium mixture. Children usually will not swallow a barium-filled capsule. In the event that there is disagreement between the findings of the roentgenologist and the pediatrician, a direct examination should be carried out. In cases of swallowed foreign bodies that have entered the stomach, it may be difficult to ascertain if the object still remains in the stomach or is in the duodenum. The roentgenologist can positively determine this by having the patient swallow a small quantity of opaque mixture to outline the stomach.

PROGNOSIS

The prognosis is dependent on the length of sojourn of the foreign body and the development of complications. In competent hands, over 98 per cent of patients can be cured. With the aid of the double plane fluoroscope, practically all foreign bodies can be removed endoscopically.

COMPLICATIONS

Complications are rarely encountered if the foreign body accident is promptly recognized, the object localized, and removed endoscopically. Prolonged sojourn of a foreign body in the air passages will usually be followed by changes in the foreign body and in the bronchi. There is retention of secretion, suppuration, infection of the bronchial wall, and, later, pulmonary fibrosis with bronchiectasis. Cicatricial changes in the bronchus are often found at the site of lodgment. The rapidity with which these occur depends very largely on the degree of obstruction, the virulence of the contained bacteria, and the patient's protective mechanism. Sooner or later, however, certain changes will result from prolonged sojourn of a foreign object in the airway. While pneumonia is often cited as a complication of bronchial foreign body, according to McCrae, it is of uncommon occurrence. Too often the drowned lung, with retention of large quantities of pus, is confused with pneumonia. In these cases, it is interesting to note that removal of the foreign body is promptly followed by a drop in temperature and clearing up of the physical signs. This would not follow if the process were a lobar pneumonia. Pulmonary abscess is an uncommon complication.

In the esophagus, there is the ever-present danger of peri-esophageal infection. Open safety pins and other pointed objects, such as bones, may perforate the esophagus and a fatal mediastinitis may develop. Fatal hemorrhage from perforation of a large vessel may occur. In one case of open

safety pin observed by the author the point penetrated the pericardium and heart muscle. In another case of long sojourn the keeper of an open safety pin eroded into the innominate artery. Early removal of the pins in both of these cases would unquestionably have prevented a fatal termination.

Foreign bodies in the stomach rarely cause trouble. Needles, large open safety pins, and long foreign bodies will often lodge in the intestines, particularly in the duodenum. Ultimately they may perforate it.

TREATMENT

This can be summed up by stating that the only method of treatment worthy of consideration is *removal by endoscopic means*. Blind methods of treatment are dangerous; there is no justification in their employment. Fluoroscopic aid, using a double plane fluoroscope, is often indispensable in the removal of metallic foreign bodies in the bronchi as well as the esophagus.

Gastric foreign bodies can be successfully removed by the gastroscope with fluoroscopic aid. Gastroscopic removal is indicated in certain pointed foreign bodies and in foreign bodies that are either too long or too large to negotiate the sharp turns in the intestinal canal. The roentgenologist is best qualified to determine this point. The most common point of lodgment is in the third portion of the duodenum, proximal to the duodenojejunal junction. With a few exceptions, a foreign body that spontaneously enters the stomach will pass without difficulty. These patients should be continued on their usual diet and laxatives should be interdicted. The foreign body should be observed daily by the roentgenologist. Surgical interference should be resorted to only when, in the opinion of the roentgenologist, the foreign body fails to make satisfactory progress.

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DISCUSSION

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atory and gastro-intestinal tracts, and it is a remarkable procedure. If a man with his experience says that he leans on the roentgenologist for interpretation, it behooves all of us to assume a great responsibility to the man in general practice who sends us films of infants' chests.

So many children are sent in without a history of a possible foreign body. In the routine reading of a child's film, if there is the slightest sign of displacement of the heart to the one side or the other, the case should be fluoroscoped. Then, if there is foreign body causing either obstructive emphysema or obstructive atelectasis, the heart will be seen to move toward the affected side on inspiration. This sign constitutes strong evidence.

DIAGNOSIS OF UTERINE AND TUBAL PATHOLOGY USING LIPIODOL

By A. TREVENNING HARRIS, M.B., CH.B.
(Edin.), SHELDON, IOWA

In the more obscure uterine and tubal pathologies, the most successful means of establishing a diagnosis—without resorting to laparotomy with its dangers and discomforts, to say nothing of the expense—is through the use of an iodized oil to assist in the roentgenographic visualization of the organs of reproduction. Lipiodol, the medium the writer has used during the past three years, is ideal in that there are no contra-indications in the pathology most commonly met with—no open blood channels such as are seen in malignancy and menorrhagia.

A normal uterine shadow is triangular, the sides of the triangle and the size varying with the individual case, the apex being the cervical end and the base the uterine fundus. The uterine tubes, which leave the two basal angles of the triangle, appear as extremely thin, wavy lines until the isthmus widens into the ampulla. Their width is much augmented before discharge into the abdominal cavity. The normal uterine and

tubal displacements were demonstrated in an examination undertaken to disprove the suspicion of an early pregnancy. The consequent mental relief in one case was the means of establishing a normal menstrual period within ten days.

A condition frequently found in examining a patient to determine the cause of sterility is occlusion of one or both uterine tubes at or near the cornual end or in the vicinity of the fimbriated end. In one of the writer's cases the left tube was occluded within 0.5 inch of the cornual end, while the right was occluded at the junction of the isthmus and the ampulla; both were with difficulty rendered patent surgically. But if the adhesions are recent or thin in character, the increased intra-uterine and intratubal pressure exerted by the oil will tend to separate the adhesions and make an early subsequent pregnancy not only possible but very probable.

When the normal central position of the uterus is found to be altered (excluding instrumental alterations), some unilateral uterine or adnexal pathology exists which is causing the deviation. To avoid exacerbation, the intracervical lipiodol syringe should be held in an exactly central position, with

no drag on the uterus to right or left, and no harmful up-pushing of the uterus, which tends to throw its body to one or the other side. In a case of dextroversion due to left-sided hydrosalpinx, adherent to the uterus, the syringe could not be held in a central position without causing acute discomfort and distortion.

In an infantile uterus, the tubes may or may not be occluded. In one case the effect of the examination was to stimulate the uterus and render pregnancy possible.

Intramural and intra-uterine fibromas are readily diagnosed by the alteration in the shape of the uterine triangle. When intramural fibroids are laterally placed they show an incurving of the uterine outline. The smaller the fibroid the more acute the nicking. Intra-uterine fibroids would naturally show a thinning of the lipiodol in the triangle in which they are situated. If they are large enough, extramural fibroids give a picture similar to dextroversion.

The most outstanding and interesting case to visualize by uterosalpingography is the bicornuate uterus. The uterine triangle is much altered, the two cornuæ being drawn outward and upward so that the cornual ends of the tubes are at a much higher level than the uterine fundus. Other pathology may be present. In one case, the uterus was completely retroverted and both tubes were occluded at the junction of the isthmus and the ampulla.

Diagnosis of pregnancy can be made as early as two weeks after a single coitus. The uterosalpingogram has two distinctive features: the breaking of the contour of the uterine triangle (which, alone, could be due to intra-uterine fibroid — itself exclusive), and the occlusion of both tubes. In one case it was seen very readily that the lower part of the triangle was thinned out at the point at which the fertilized ovum had implanted itself. In a second case it was deemed impossible that the patient could be

pregnant as abortion had been attempted and a four-day bleeding had resulted. When, some weeks later, abdominal pain and intractable vomiting overcame the patient, the case was diagnosed as typhoid fever; but the uterosalpingogram altered the diagnosis completely. At the time of the examination (exactly six weeks from the date of a single coitus) it was seen that the uterine outline was much enlarged, with marked irregularity of the triangular outline owing to the presence of the fetus (superiorly), and the more regular placenta (inferiorly, and to the right).

It has been held that uterosalpingography is liable to cause abortion in the early pregnant uterus. In neither of these cases was the pregnancy disturbed by the introduction of the lipiodol into the uterus, and the writer feels that this would be true of most cases if the physician making the examination ceased introducing the oil as soon as his patient complained of "cramps." It has been the writer's custom to make a small film of the pelvis when this complaint is made; invariably it has proved to be the right time at which to stop. I have then proceeded to make the main exposures of the case—stereoscopic films 14 by 17 inches, taken either vertically or laterally, and always on the Bucky diaphragm.

CONCLUSIONS

1. Uterosalpingography is an unrivalled means of establishing a diagnosis in uterine and tubal pathology and abnormalities which cannot be detected with any degree of certainty except by laparotomy.

2. An accurate means of diagnosing the cause, or causes, of sterility in women otherwise normal and with normal husbands.

3. Uterosalpingography is a most useful aid in establishing with certainty, with little or no risk to either the mother or the embryo, the presence of the earliest stages of pregnancy.

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is most gratifying to note that the most outspoken commendation is in numerous instances over the signature of a radiologist of renown—one who is unquestionably conversant with the medical literature of the world. Instances are: "To me it is very satisfactory"; "Keep up your present standard"; "No improvement necessary"; "It has no equal as a radiological publication"; "It contains excellent original articles, and a quite comprehensive abstract of the literature"; "It is an excellent continuous post-graduate course"; "I have often wondered how the Society is able to give as good a Journal as they do for the amount they receive"; "Seems to be continually improving"; "Excellent contents and make-up"; "We await the coming of the Journal each month, and appreciate it immensely," and, as a cap sheaf, this one: "I believe that the Journal as published to-day is the best of its kind—its policy, continued, will keep it so."

COMMUNICATIONS

THE PROGRAM FOR THE AMERICAN CONGRESS OF RADIOLOGY

The American Congress of Radiology is to be held in Chicago, September 25 to 30, 1933, inclusive. This Congress is intended to take the place of, or rather, combine, the regular annual meetings of the American Radium Society, the American Roentgen Ray Society, the Radiological Society of North America, and the American College of Radiology. This is done for the purposes of economizing time and expense, and, instead of compelling one to make three or four trips across the continent, to permit us to attend the Century of Progress Exposition.

It is planned to hold a Scientific Program during six days, from 9 A.M. to 2 P.M., with an intermission of twenty minutes. The

remainder of the afternoons and all of the evenings, excepting one, are to be left free for attendance at the Exposition, study of the scientific and commercial exhibits, and for the holding by the various societies of their executive sessions.

It is proposed to hold the Convocation of the American College of Radiology under the management of the officers of this organization; the Convocation of the Radiological Society of North America, together with the award of its medals, under the management of the officers of this organization; to have a banquet; to have the Caldwell Lecture, arranged for by the management of the officers of the American Roentgen Ray Society, and to have a lecture on one of the outstanding radium pioneers, under the management of the officers of the American Radium Society.

Because of the fact that we are limiting the Scientific Program to four hours and forty minutes on six days, or a total of twenty-eight hours, which must include all discussions, addresses, introductions, etc., it is self-evident that the program must be somewhat limited, and that every speaker must adhere strictly to his time, this time to include the presentation of his paper as well as the presentation of lantern slides. In spite of this fact, the Program Committee and the Council which is arranging this program, desire that, so far as is practical, all advance information and conclusions be presented at this meeting. We are, therefore, asking the members of the various radiological societies to offer to the Committee any paper that will be helpful in making this Congress a great success. Also, I am asking each member who knows of advanced work being done by some other member, please to give us this information. Please make these offers as promptly as possible, for in carrying out such a large project, delays must be avoided.

GEORGE E. PFAHLER, M.D.
Committee on Scientific Program.

EDITORIAL

LEON J. MENVILLE, M.D. Editor
BUNDY ALLEN, M.D. Associate Editor

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THE QUESTIONNAIRE CONCERNING "RADIOLOGY"

Previous to the St. Louis meeting of 1931, Dr. W. H. McGuffin, Chairman of the Publication Committee at that time, sent questionnaires to all subscribers of RADIOLOGY, submitting inquiries as follows: (1) "Are you favorably impressed with RADIOLOGY as it is to-day?" (2) "Have you any suggestions for the improvement of the Journal?"

In Dr. McGuffin's report he stated that 50 per cent, or about 1,200, of those receiving the questionnaire responded; since then, about a hundred more replies have come in. So much for the response.

Of the replies received by Dr. McGuffin, he stated that something over 95 per cent, or 1,140 out of 1,200, expressed satisfaction and stated over the signature of the reader that he was "favorably impressed." This result is most gratifying and encouraging to all concerned; however, it is from the dissatisfied 5 per cent, or 60 out of 1,200 replies, that we look for helpful suggestions for improvement.

Since the size of the Journal has been reduced during the last six months, we may consider that we have more than met the wishes of the 28 who said it was "too ponderous," "getting too large," etc., and advised us to "strive for quality rather than quantity."

Several thought thinner paper should be used, and even more advised a tougher cover

paper, the foreign subscribers especially saying that both cover and mailing envelope should be more durable stock. One subscriber, who is a frequent contributor as well, "would like to see a Journal made up of reprints, fastened together with some kind of clip, so that they can be re-arranged." So much for format.

Three of the answers advised consolidation of Journals, and 20 made suggestions as to the *writing* of papers rather than to the *publishing* of them, the latter being the problem with which we are immediately concerned.

The larger number of those making suggestions for improvement advise more clinical and less physical material, a large enough "minority report" to merit consideration. The Journal is committed to the publication of such papers as are read at the Society's Annual Meeting, and contributions, and we are guided by the expressed preference of our readers in the choice of the latter. In a large measure, abstracts of papers on physical subjects are being omitted, acting upon these suggestions.

Nine of the replies advise diagnostic rather than therapeutic papers, but nine hardly balance with the thousand and more which make no such suggestion: "objection overruled."

Eleven suggest more illustrations and three desire better ones. One suggests an index, overlooking the fact that indexes had been published every six months to that date. Three suggest just such a Subject Index as is now in preparation. About an equal number wish more abstracts and fewer; necessity has compelled us to act upon the suggestion of the latter.

It would be unfair to quote names, but it

petent judges of medical literature, have written him of their satisfaction in the Society's Journal, even though its size has been diminished.

Acknowledgment is due those authors who have furnished their own illustrations with the utmost good nature, since the Society has been unable to do so.

The Cole Collaborators offer a correspondence course in roentgenologic gastro-intestinal diagnosis, which includes a correlation of anatomical and pathologic find-

ings with roentgenographic findings, and an application of these to all the problems of gastro-enterology — etiology, pathogenesis, process of repair, diagnosis, and indication for medical or surgical treatment. This course consists of 22 assignments, one each week for five months. It requires at least two hours a day for the student to read the text, prepare his drawings, and write his answers, which are returned to the Cole Collaborators for correction and criticism.

Those interested may write to the Cole Collaborators, 36 East 61st St., New York City.

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Howard P. Doub, M.D.	Hans W. Hefke, M.D.	H. C. Ochsner, M.D.	C. G. SUTHERLAND, M.D.

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CANCER (DIAGNOSIS)

The Incidence of Carcinoma in Certain Chronic Ulcerating Lesions of the Stomach. G. W. Holmes and A. O. Hampton. Jour. Am. Med. Assn., Sept. 10, 1932, XCIX, 905-909.

The authors believe any chronic, indurated, ulcerating lesion, occurring in the pyloric antrum within one inch of the pylorus, but without involv-

ing the pylorus, should be considered malignant until proven to be otherwise, and that proof of the absence of malignancy in such lesions is obtained only by serial section and careful microscopic examination. It is not safe to interpret such lesions as benign from roentgen examination alone or from observation on the operating table.

C. G. SUTHERLAND, M.D.

FIFTH DISTRICT MEDICAL ASSOCIATION OF TEXAS

This Association held a splendid Post-graduate Meeting in San Antonio, Texas, Jan. 10-12, 1933, with an attendance of some eight hundred and much enthusiasm. As expressed in the Foreword of the program: "In these times especially, when so few of us can afford either the time or the money required for post-graduate study at the medical centers, this program should supply that stimulus so necessary both for our morale and for our interest in scientific medicine." Apparently it did.

A feature of especial interest was the round table sectional meetings, two and a half hours in length, at which opportunity was given to ask questions of the speakers.

We mention only certain of the presentations of value to radiologists, as follows: "What Every General Practitioner and Specialist should Know about Recognition and Treatment of Cancer," Joseph C. Bloodgood, M.D., of Baltimore.

"Uses and Abuses of Radium in Malignancy," and "X-ray Responsibilities in Incipient Pulmonary Tuberculosis," Edwin C. Ernst, M.D., St. Louis.

"Practical Value of Intravenous Urography in General Diagnosis," William F. Braasch, M.D., Rochester, Minn.

"Bronchoscopy of Foreign Body Diseases of Lungs," Gabriel Tucker, M.D., Philadelphia.

The officers of the Association are: S. F. Thompson, M.D., of Kerrville, Texas, *President*; H. McC. Johnson, M.D., of San Antonio, *Vice-president*; T. E. Christian, M.D., San Antonio, *Secretary*.

THE AMERICAN SOCIETY OF RADIOGRAPHERS

The next annual meeting of the American Society of Radiographers will be held in Rochester, New York, from May 31 to June 3, 1933.

So many radiologists prefer to have associated with them, to do expert technical work, men and women who are members of the above-named association of technicians, that numerous physicians and physicists are always sure to be represented on its programs. It is still too early to announce the speakers, but the American Society of Radiographers has never failed to have practical, skillfully conducted meetings, vibrant with enthusiasm.

IN MEMORIAM

ALFRED LEFTWICH GRAY, M.D.

Dr. Gray, a former President of the American College of Radiology, died on October 13, 1932, after an illness of nearly two years. The *Medical Monthly* of his native State, Virginia, has printed a splendid biographical sketch of Dr. Gray, bespeaking the high regard in which his co-workers held his scholarship, attainments, and character.

ANNOUNCEMENTS

AN INCREASE IN THE SIZE OF "RADIOLOGY"

Readers will note that with this month's issue is begun what we trust is to be a steady increase in the size of the monthly issues of this Journal: eighteen pages have been added. The sharp decrease in the number of pages, which took place during the past year, was occasioned by the fact that the Society could not otherwise "balance its budget." Every possible economy has been effected with the object of turning all available funds into increasing the number of pages to be devoted to the publication of papers read before the Society and contributed by readers.

The Editor has been encouraged in his endeavor to maintain the high standard of RADIOLOGY by those who, themselves com-

variable periods of time can be attained by external irradiation supplemented by calcium, phosphorus, and ergosterol for stimulation of bone repair, and supportive jackets for the collapsing spine cases. The author advocates roentgen treatment for cases clinically suggesting osseous metastases, even if definite radiographic evidence of such extension is lacking.

J. E. HABBE, M.D.

Late Results of the Fractionated Irradiation of Carcinoma of the Larynx (1922-1927): A Contribution to the Question of Protracted or Shorter Single Treatments. A. Gunsett. *Röntgenpraxis*, March 1, 1932, IV, 214-223.

Of 23 cases of laryngeal carcinoma treated between the years 1922 and 1927, 5 cases, which is 21.7 per cent, were cured for three years and over. The greatest number were advanced cases. Of 10 cases, with a carcinoma confined to the larynx alone, four remained cured; one for nine years, one for six years, and two for four years. In this small group the protracted type of irradiation did not seem to play an important rôle. In exolaryngeal cases in which the cancer extended above the larynx proper, protraction of the single treatment appeared to be of importance. In four cases the tumor disappeared completely, at least temporarily, with a corresponding alleviation. Lately, the author gives 3,500 r (measured on the skin through two lateral fields). The daily dose is 300 r, given in about one hour (2 mm. Cu and Al filter, 50 cm. distance). In exolaryngeal cases the entire dose is still larger, while the focal skin distance is increased to 65 centimeters.

H. W. HEFKE, M.D.

Irradiation of Mammary Cancer with Special Reference to Measured Tissue Dosage. Burton J. Lee, George T. Pack, Edith H. Quimby, and Fred W. Stewart. *Arch. Surg.*, March, 1932, XXIV, 339-410.

The authors believe that the pre-operative external irradiation for mammary carcinoma is of value. This is shown by: (1) The occasional regression of tumors so treated; (2) the histologic changes produced, and (3) the better clinical end-results.

They believe that a sufficient devitalizing dose cannot be delivered by external irradiation alone, but that one must supplement this with interstitial irradiation. The tissue dose delivered to the tumor should be measured and expressed in skin erythema units. This dose expressed in skin erythema units can be determined, whether external or interstitial irradiation is used. The universal tissue dosage necessary to effect destruction of a radioresistant mammary cancer approximates twelve skin erythema doses.

The safest procedure is to treat all patients with mammary cancer with the same sufficient dose be-

cause (1) radiosensitivity cannot always be determined before operation, and (2) the same tumor may contain radioresistant and radiosensitive areas. These tumors vary a great deal with respect to radiosensitivity. The mammary gland itself will tolerate safely large doses of interstitial irradiation. The authors have not seen any evidence of dissemination of the disease by interstitial irradiation, and they believe that preliminary external irradiation lessens this possibility. They give all the pre-operative irradiation within a period of three weeks or less, and then wait at least six weeks before a radical amputation is performed.

Their present method for treatment of primary operable mammary cancer is external irradiation; then interstitial irradiation, and finally radical amputation six weeks later. The axilla is irradiated by: (1) Pre-operative roentgen rays or radium element packs followed by (2) interstitial gold filtered radon, distributed along the gland bearing areas.

They believe that primary inoperable cancer of the breast should be treated by proper measured doses of irradiation to insure the disappearance of the cancer in the breast and adjacent lymph nodes. This method constitutes the procedure of choice and is the only available measure for palliation and possible cure for inoperable carcinomas of the breast.

In recurrent carcinoma of the breast, most of the cases are inoperable, and these, by necessity, should be treated by radiation therapy, as it offers the only hope of arresting or eliminating the disease, or relieving many of its distressing symptoms. In a few cases these tumors are of such nature that they can be completely excised.

The pathologic changes produced in mammary cancer by external irradiation are mainly due to vascular effects. They are moderate hydropic swelling of the tumor cells, moderate atrophic degeneration, marked collagen swelling, productive arteritis, with thrombosis and calcific deposits in the vessel walls, and productive fibrosis.

The changes produced by interstitial irradiation are mainly direct effects on the tumor tissue, namely, ballooning degeneration; hydropic swelling; giant nuclei and atypical degenerative mitoses; a tendency toward squamous metaplasia, followed by sloughing; hemorrhage; infiltration by fatty macrophages, with ensuing extensive calcific deposits; often acute capillary necrosis, with resulting tumor necrosis; squamous metaplasia of normal adjacent globules of the breast; collagen swelling; productive fibrosis, and late atrophy of the residual tumor.

HOWARD P. DOUB, M.D.

CHEST (DIAGNOSIS)

Common Inflammatory Diseases of the Lungs as Depicted by the Roentgen Ray. B. R. Kirklin. *Med. Clin. No. Am.*, May, 1932, XV, 1545-1550.

The author is of the opinion that the more com-

CANCER (THERAPY)

The Application of Chemotherapy in the Treatment of Carcinoma. G. Ernst. *Strahlentherapie*, May 11, 1932, XLIV, 97-108.

The author briefly reports his experience with the combination of the oral administration of LiMgJ_2 —pectin compound—with X-rays in treating malignant tumors. A total of 54 patients, all with inoperable neoplasms, are analyzed. In 40 of these, a favorable effect of the combined treatment could be noted. This was even more striking in five cases of sarcoma. An extensive bibliography is appended to the article.

ERNST A. POHLE, M.D., Ph.D.

Healing of Wounds in Tissue Irradiated Preceding Operation, with Special Consideration of Breast Cancer. O. Jüngling. *Strahlentherapie*, May 11, 1932, XLIV, 125-130.

In 52 patients, with operable carcinoma of the breast, observed from October, 1930, to March, 1932, the author studied the following questions: (1) Can a technic be developed to irradiate carcinoma of the breast successfully without injuring the surrounding tissue? (2) Does pre-operative irradiation render the following operation difficult? (3) How do the wounds heal in the irradiated area if radical operation is done with the knife or by the endotherm method? (4) How do the wounds heal if, after operation, the gland-bearing areas receive radium implantation?

The technic of irradiation was the same as is practised in the Radiumhemmet, Stockholm. From three to six weeks later, the operation was performed and immediately following operation radium gold needles up to 200 mg. radium element were inserted. The tumor did not increase in size after irradiation.

In about 60 per cent of the cases there was very little difficulty added to the operation. In five cases the operation was about twice as difficult because of the induration of the tissue. Seventeen cases were operated on surgically, while in 35 the endotherm method was used. Of the first 17 patients, the wounds healed without complication in 16, one having a mild erysipelas. Of the second group, two advanced cases died from heart failure following operation. In three cases necrosis appeared, apparently due to an improperly functioning diathermy apparatus. Two others showed small areas of necrosis, and in two cases which had healed *per primam*, there was a serous discharge of considerable duration. Transplantations, when necessary, took well in spite of the fact that skin from the irradiated surrounding tissue was used.

No end-results can be presented because the cases have not been observed long enough. The author,

who is a surgeon, concludes that from his standpoint there is no contra-indication to pre-operative irradiation and prophylactic radium implantation after removal of the breast.

ERNST A. POHLE, M.D., Ph.D.

Old and New Theories with Regard to X-ray Dosage in Cancer. F. Hernaman-Johnson. *Proc. Roy. Soc. Med.*, April, 1932, XXV, 774-777.

The author feels that roentgen irradiation cures principally by stimulating local and general tissue resistance. The use of a dosage destructive to tissue surrounding the malignant lesion should be limited to desperate cases. He states that the results in carcinoma of the breast can be improved only by the continuous effort to maintain the patient's resistance against possible metastasis.

H. C. OCHSNER, M.D.

The Treatment of Metastatic and Inoperable Mammary Cancer, with a Discussion of Certain Distinct Types of Metastasis. Frank E. Adair. *Am. Jour. Roentgenol. and Rad. Therapy*, April, 1932, XXVII, 517-531.

The discussion in this paper is limited to the treatment and results of primary inoperable, recurrent inoperable, and metastatic cancer of the breast, as carried out at Memorial Hospital, New York City. The chief forms of treatment made use of are: (1) Irradiation, both external and interstitial; (2) surgery, including palliative excision of necrotic, foul-smelling tissue, and the occasional removal of a local recurrence, lymphangioplasty, and chordotomy; (3) electrocoagulation; (4) supportive jacks, in vertebral involvement, and (5) medication in the forms of irradiated ergosterol, phosphorus, and calcium lactate.

Metastases to the axilla represent a difficult form of the disease to successfully treat, but by combining interstitial radiation with externally applied high voltage roentgen therapy to the extent of from 600 to 700 per cent S.E.D. into the center of the axillary chain of disease, satisfactory results can often be achieved without inducing a brachial neuritis.

Supraclavicular metastases, often in the form of a single fairly large node just above the middle of the clavicle, are usually responsive to a lesser amount of radiation than is necessary in the axillary involvement. Radium packs and high voltage roentgen therapy are used.

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mon inflammatory diseases of the lungs should always occupy the foreground of the examiner's consideration and he, therefore, reviews the fundamental signs of these conditions. In the interpretation of roentgenograms of the thorax it is imperative, as a general rule, that due allowance be made for normal variations and purely secondary phenomena, and that judgment be conservative.

Incipient cases of pulmonary tuberculosis may be divided into two groups: In the first, which comprises by far the greater number, the earliest visible manifestation is an area of slight opacity in an upper lobe, more often of the right lung, just below the clavicle and in the parenchymatous portion of the lung. The shadow has been likened to a web spun by caterpillars about an outer branch of a tree. The lesions of the second group are similarly situated but are roughly spherical and usually multiple. Extremely limited, simple inflammatory or thrombotic processes, localized partial atelectasis, the residue of acute infection, or slight bronchiectasis may resemble the irregularly conical web produced by early tuberculosis.

Advanced tuberculosis in adults is made up of varying proportions of simple or conglomerate tubercles, gross nodules, caseous pneumonia, fibrosis, calcification, cavities, bronchial dilatations, local atelectasis, or compensatory emphysema, contraction of the lung, pleural thickening, adhesions, and pleural effusion. The disease tends to progress from above downward, so that the newer lesions are in the advancing margin below.

In children, primary tuberculosis produces a somewhat different pathologic picture, for the lesions tend to involve areas surrounding the hilus and lower lobes more often than in adults. Caseous bronchopneumonia, with scanty fibrosis and enlargement rather than calcification of the tracheal, bronchial, and pulmonary lymph nodes, is noted in the tuberculosis of childhood. The differential diagnosis is chiefly from bronchopneumonia, which produces a similar mottled shadow.

In miliary tuberculosis the pulmonary fields have a finely granular appearance, and the tubercles are seen as countless small, faint shadows distributed rather evenly throughout the lung fields or grouped somewhat in the upper lobes. Miliary metastasis and mild forms of pneumoconiosis are to be distinguished from this form of tuberculosis.

Little is seen in lobar pneumonia during the stage of engorgement, except some enlargement of the shadow of the hilum and intensification of the vascular markings. This is followed by a delicate, uniform veil-like shadow over the affected lobe. During the stage of hepatization the density of the shadow is increased and some part of the margin is usually sharply defined. In the stage of resolution the appearance of the involved areas has been compared to that of a thin piece of melting ice.

The posterior portions of the lower lobes are most commonly involved in bronchopneumonia, and the shadows which are scattered along the bronchovascular markings vary considerably. An early and persistent sign in this condition is elevation of the diaphragm of the affected side.

Pulmonary abscesses are usually located in the central portion of the lower lobes. In the early stage the shadow of an abscess is rather homogeneous, but when softening begins it becomes mottled.

Bronchiectasis is relatively common, and while the dilatations may occur in the principal bronchi of any lobe, they are more frequently seen in those of the lower lobes. When filled with secretions they produce shadows which resemble a bunch of grapes. Bronchography is especially valuable in demonstrating these dilatations.

J. N. ANÉ, M.D. *

CHEST (GENERAL)

A Clinical Note on Successively Contemporaneous Bilateral Pneumothorax. Collatino Cantieri. *Riv. di Patol. e Clin. della Tubercolosi*, April, 1932, VI, 330-339.

Successively contemporaneous bilateral pneumothorax gives better results than bilateral successive, but not contemporaneous, pneumothorax. The lung may be kept collapsed for one or two years until a favorable condition is obtained. In producing pneumothorax the minimal effective pressure should be used. The author has noted a more rapid absorbability of air on the side treated last. A rare complication is pleuritis; even if it is accompanied by exudate, it is tolerated well.

E. T. LEDDY, M.D.

The Gastrocardiac Syndrome Following Left Phrenic Exeresis. Giacomo Jurcev. *Riv. di Patol. e Clin. della Tubercolosi*, April, 1932, VI, 320-329.

The author reviews the literature on the gastrocardiac syndrome first described by Roemheld and adds a case of his own. This complex consists in a sense of oppression in the chest and of constriction and pain in the cardiac region. The pain is localized at the apex of the heart, more uncommonly behind the sternum, and may radiate to resemble the pain of angina pectoris. There may also be present difficulty in breathing, a sense of respiratory rigidity. There may be bradycardia and extra systoles, or tachycardia. These heart symptoms are accompanied by vertigo, nausea, and vomiting. The author thinks that in addition to the mechanical upset to the diaphragm and gastro-intestinal tract, a nervous factor in the neurovegetative system may play a rôle in this syndrome.

E. T. LEDDY, M.D.

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BRONCHOGRAPHY IN CHILDREN

Iglauer states (Jl. A.M.A.):—

"Bronchography has not been so generally adopted in children, chiefly because of the difficulty in obtaining the cooperation of these young patients.

"While the ordinary roentgenogram of the chest is of great diagnostic value, there are many lesions that can be visualized with much greater certainty and clarity after the introduction of opaque substances. The best medium for this purpose is iodized poppy-seed oil 40 per cent (lipiodol), since it is practically non-toxic, easily manipulated, and very opaque to the x-rays. The value of bronchography is demonstrated particularly in cases of bronchiectasis. The opaque oil not only renders the cavities visible, but also shows their approximate shape, number, size and distribution."

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1. Left antrum: Central filling defect indicating presence of new growth. 2. Right antrum, same patient: normal filling with LIPIODOL. Photos courtesy Dr. George D. Wolf, New York.

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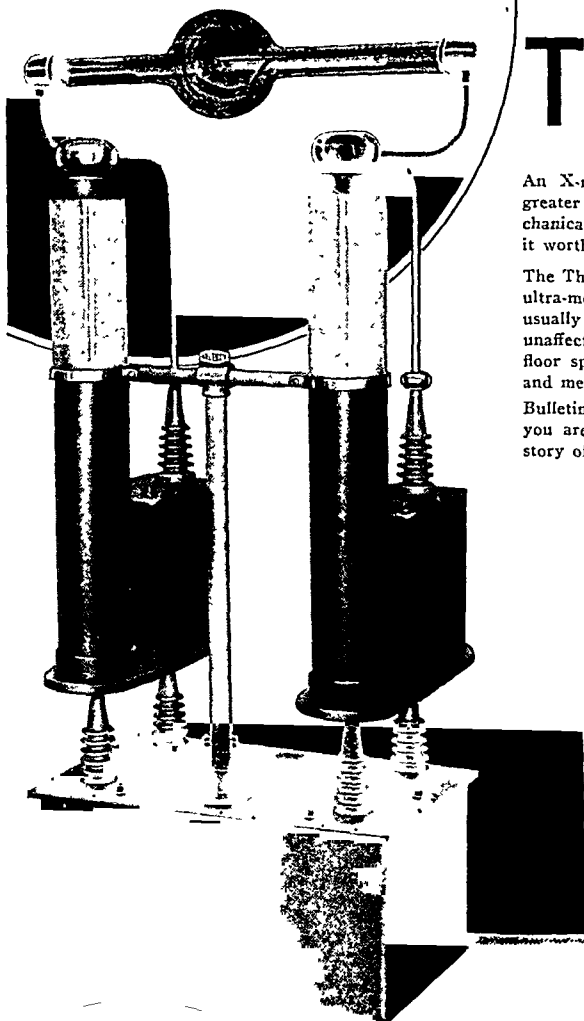
In these doubtful cases Lipiodol may be of great assistance in properly visualizing whatever pathology is present.

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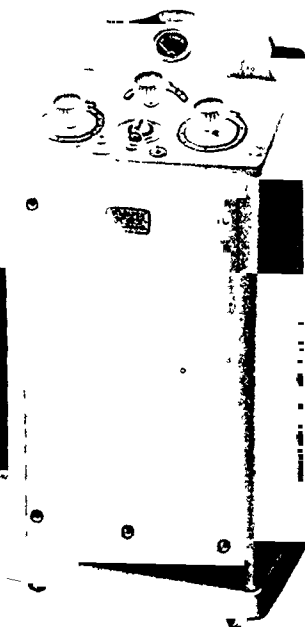
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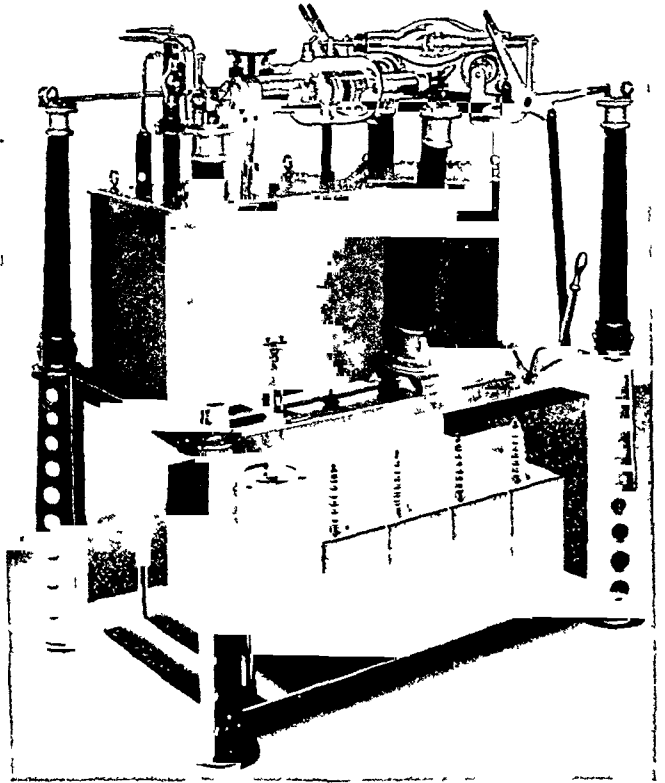
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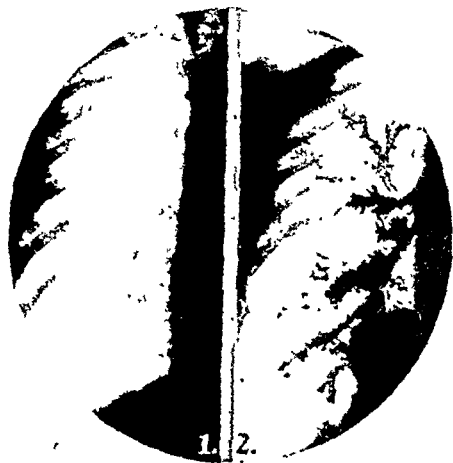
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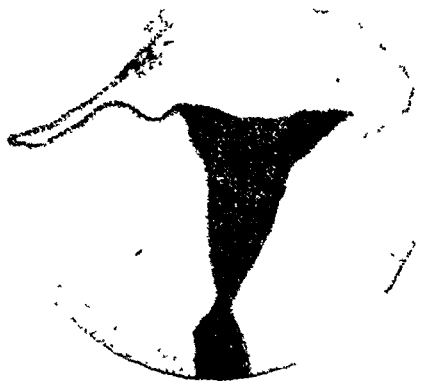


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1. Roentgenogram before injection. Appearance practically normal. 2. Same after Lipiodol injection. Bronchiectatic abscess in right lower lobe previously invisible. Photos courtesy Dr. David H. Ballon, Montreal.



Occlusion of both fallopian tubes as shown by injection of 7 c.c. LIPIODOL. Photo by courtesy Dr. Julius Jarcho.

CHEST ROENTGENOGRAPHY

There are three methods employed for introducing Lipiodol into the broncho-pulmonary apparatus: (1) supraglottic, (2) bronchoscopic and (3) intercrithyroid.

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After pharynx and larynx are anesthetized with cocaine or procaine, patient is instructed to grasp tongue with piece of gauze and pull it forward. Oil, previously warmed to body temperature, is dropped into the glottis while cords are open. If right lung is to be filled, patient leans to right; if left lung is to be examined, patient is inclined to left.

Intra-tracheal and intra-pleural injections should be avoided in tuberculosis of the respiratory organs and also when restriction of respiratory area would be contra-indicated.

TURN THE PAGE for "Bronchography in Children" and "Radiography of Paranasal Sinuses".

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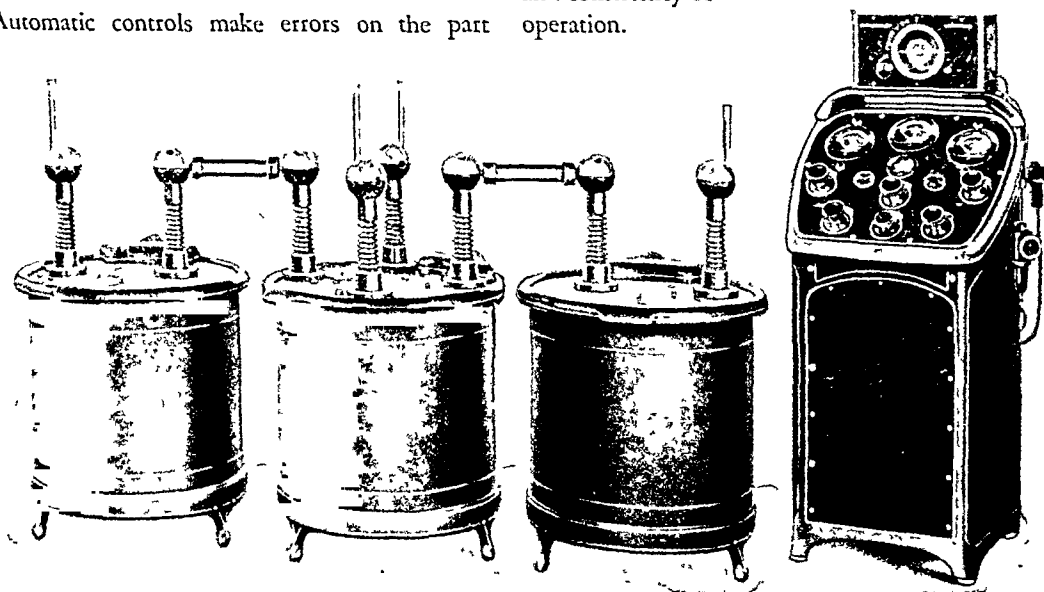
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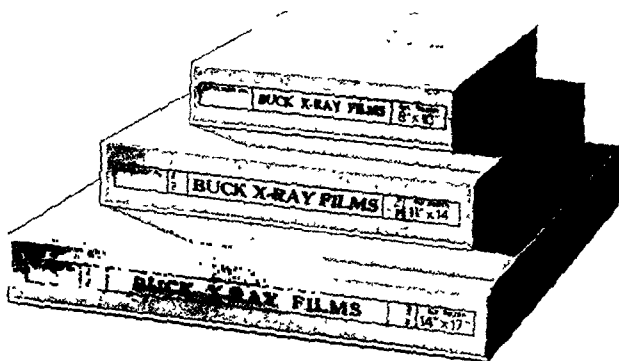
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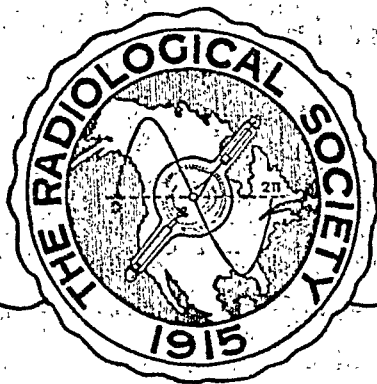


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Volume XX

Number 1

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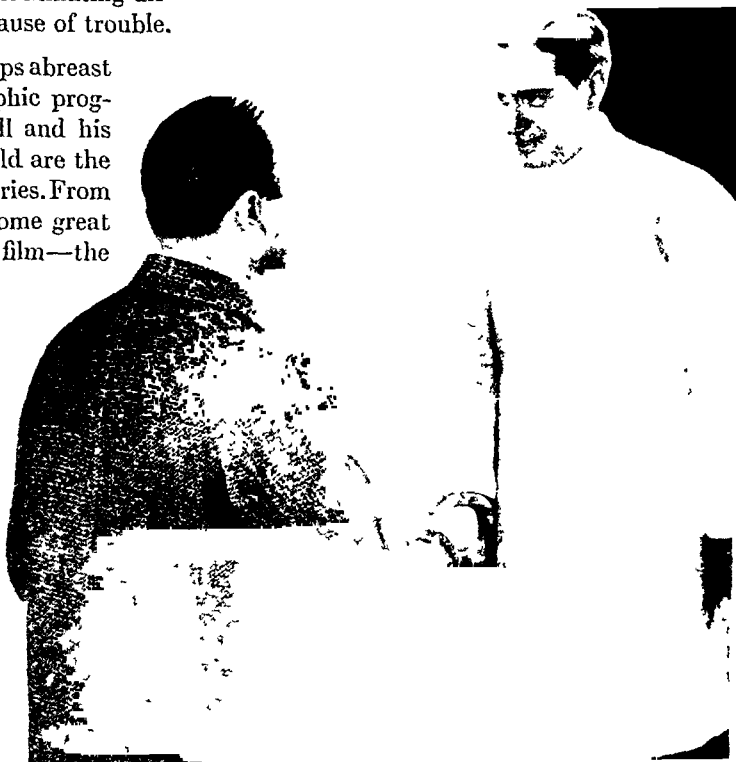
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RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

VOL. XX

JANUARY, 1933

No. 1

NEW APPLICATION OF FLAT BUCKY GRID TO ANY ANGLE WITH SPECIAL REFERENCE TO SINUS WORK¹

By PAUL F. COLE, M.D., SPRINGFIELD, MISSOURI

ONE has to examine the dried skull only casually to note the roentgenologic difficulties in its examination with special reference to the paranasal sinuses. We all agree that roentgenograms of the paranasal sinuses must be of excellent quality in contrast, detail, and definition. Just how these results are best obtained is still a debatable question, and, on the whole, roentgenographic examinations of the paranasal sinuses are far from being standardized. A recent text-book (Proetz) on the subject begins, "Discouragingly little is known about sinuses."

The use of the Potter-Bucky diaphragm routinely in head work appears never to have been practical. The reason is clear to all. Just which method of procedure is the best, that is, whether to use the Bucky, or to dispense with it, and use the long narrow cone, does not come within the scope of this paper. The point we wish to make is that, if one so desires, he may use the flat rectangular Bucky grid for any of the many tube tilts and shifts required in the examination of the skull. One other point which we think has been fairly well established in sinus work is that an 8×10 film divided in halves is of sufficient size to show any

particular group of sinuses diagnostically. This procedure saves both time and money.

So far as we know, the only solution of adapting the flat Bucky grid to various angles, up to the present time, has been a Bucky so constructed that interchangeable grids especially built for the various angles were used, or the spiral type of grid. For some reason neither of these types has thus far gained wide popularity in America.

Some years ago we made a spiral grid. At that time the idea of an interchangeable grid, which we first learned of through the work of Dr. Potter, did not occur to us. The spiral grid we constructed appeared to be an excellent piece of workmanship, and on trial it made the most beautiful circles on films anyone might wish to see. After discovering our mistake along this line we then conceived the idea of mounting a flat rectangular grid so as to accomplish the results we had hoped to obtain from a spiral grid.

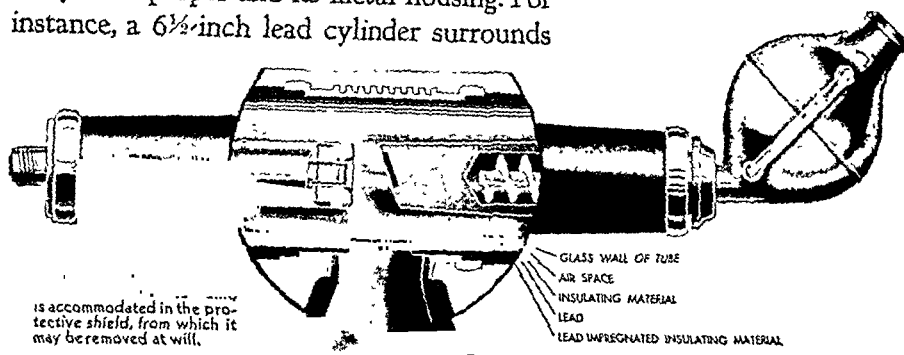
This was accomplished by reassembling the parts of a regulation stock Bucky and having a specially built small grid, 1 to 4 ratio, 0.25 inch thick, installed. This grid and the other mechanical parts of the Bucky were mounted on a rotating aluminum disk, covered with lead to protect the unexposed film. This disk has a diaphragm in the center, 5×8 in., permitting exposure

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1911.

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The intensity of radiation in directions other than that of the useful x-ray beam is really negligible. Specifically, it is even less than that which gets through a 1/16-inch thickness of lead placed in the main x-ray beam. In other words, this protection is as effective as though the x-ray source were placed within a 1/16-inch lead drum.

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lapping in the exposures. It is this circular diaphragm which permits us to use the grid at various angles for making two uniform exposures on the same film. Should it be left out when one is operating at various angles, the exposures on the film will overlap.

The face of the disk, which is covered with leather, is marked off in such a way as to provide a convenient and accurate method of re-positioning the patient, enabling us to duplicate exposures at any time. At the top of the disk, near the outer margin, is a knob or handle which is used to rotate the disk conveniently. In this handle is a small level which allows us to set the disk absolutely perpendicular to the floor, when necessary. Slightly above this knob and to the left will be noted a set-screw in the orbit. This screw is used for holding the disk in proper position.

Figure 3, a back view of this device, is largely self-explanatory. The grid is not of the exact length desired but we did not wish to sacrifice any of its dimensions for this experimental work. As previously stated, it is a 1 to 4 ratio, 0.25 inch thick. Other ratios and thicknesses may prove of more value. The bell is arranged to signal both the beginning and ending of grid travel; about 0.5 inch of grid is moved at the first signal and about 0.5 inch remains to move at the end of the second signal. The assembly of the grid is on a cold-drawn brass rod which acts as a track to support the grid attached. The pump is so located that the piston acts for the opposite track. This arrangement, we think, might be greatly improved to reduce friction; nevertheless, it appears to run very smoothly.

A protractor for measuring the tube angles is attached to the axis line of the grid on the right side of the machine (Fig. 4), and works with the orbit and other parts of the device. The protractor is marked off in degrees starting at the top with 90°.



Fig. 2. The circle within the lead pan shown on the left is 5 inches in diameter and exactly covers one-half of an 8 X 10 film. This pan is needed only when using various tube angles. The pan in the center is called the grid indicator and is made of sheet metal somewhat resembling the hand of a sundial. On the right is a flashlight mounted in the center of a tin cap which fits over the cone, indicating the path of the central ray.

indicating the vertical position of the disk which carries the grid in relation to the tube. The degrees are then marked down on the protractor so that 0 indicates the horizontal position of the orbit in relation to the tube. Starting at 0 and going on around the protractor the tube will reach 90° (below) and again form a vertical position in relation to the orbit. The indicating hand is placed centrally on the tube arm. This arrangement permits us to tilt the grid either backward or forward from its vertical position without giving any attention to the degree of tilt, since this can suit the convenience of the patient when he is being examined. The tube arm indicator is brought to the 0 point of the protractor, and the central ray is then always perpendicular to the film. From this point we may raise or lower the tube arm to any degree of angulation we wish. The tube head carriage is also marked off in degrees, permitting the tube to move either to the right or left. For illustration, in making frontal sinuses we would tilt the disk away from the patient to any convenient position, bring the tube arm indicator to 0, and then elevate it 23°. The patient then is in the same position as though he were placed on a 23° angle board.

For the "G" line technic it is necessary only to position the patient's head properly

of one-half of the film. The disk is mounted within a metal ring, termed the orbit. In the orbit are ball-bearing rollers that fit into a track on the disk (Fig. 1). The orbit is marked off into degrees, starting with 0 at

30 inches, which, however, can be reduced to 20 inches if desired. The tube holder is provided with a stereoscopic shift, vertical and horizontal, or the degrees marked off on the tube carriage may be used for this

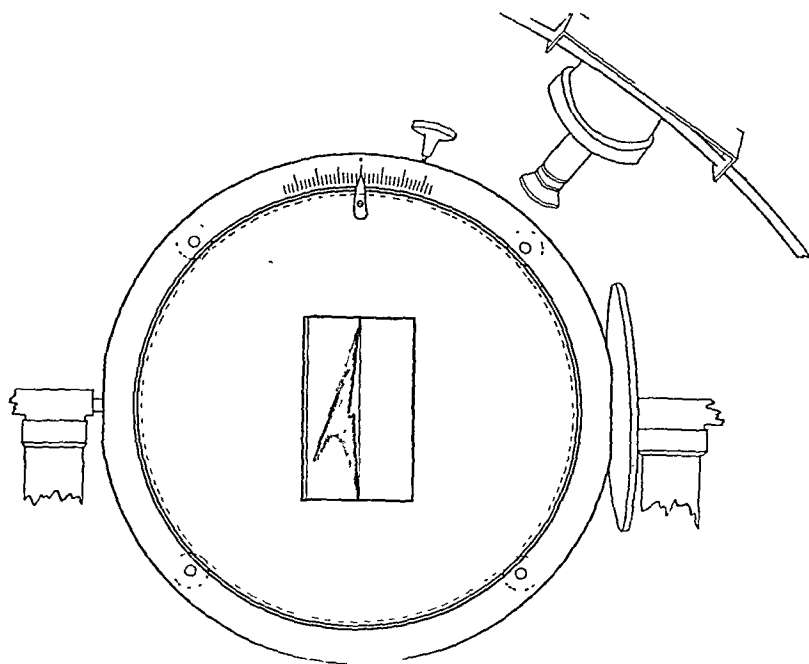


Fig. 1. The outside ring, termed the orbit, in which roller bearings are set. The inside ring is an aluminum disk with indicating hand showing position of grid with relation to central ray. The shadow in the center is made by an indicating hand, termed the grid indicator. The opening in the aluminum disk is 5×8 inches. The front of this disk is covered with lead, on top of which is placed leather upholstery. The set screw at the extreme top passes through the orbit and makes contact with the disk, acting as a locking device.

the top and going to the right and left through the equator of the orbit, giving a total range of 180° . The disk has an indicating hand pointing to the degree of rotation to the right or left from the vertical position. By rotating the disk, which acts as a chassis for the Bucky mechanism, we are able to bring the grid into proper position, as will be explained later.

The tube-carrying device is so arranged that any degree of shift is easily obtained in the cranial, caudal, ventral, or dorsal direction. The film-target distance is set at

purpose. The amount of shift is determined by dividing the target-film distance by 9 and using that factor. The opening, or window, in the disk is arranged to cover half of an 8×10 film. The cassette holder is attached to the orbit, which remains stationary, thus holding the film in unvaried position. When the tube is set at some angle other than the true vertical position, a circular disk or diaphragm, 5 in. in diameter, is placed in position (Fig. 2). This is ample size for sinus work, giving uniform position on the plate, or film, with no over-

you will first place your patient in position before the diaphragm; then set the tube at the angle you wish so that the central ray passes directly through the anatomic point to be examined. This will necessarily bring your central ray to the center of the film. Then have the patient step aside and place in the opening of the disk a small frame resembling the hand of a sun dial. This instrument we designate as the grid indicator (Fig. 2). By using a flashlight so mounted that it fits over the outside of the cone, as illustrated, you will note that the light falls on the grid indicator, casting a shadow to either side. This light indicates the path of the central ray. You will then release the set screw at the top of the orbit, permitting the dial which carries the grid and its mechanism to rotate either to the right or left as indicated, until the shadow cast by the dial indicator disappears from view. You will then note on the orbit the degree of rotation of the grid. Locking the dial in this position you are now ready for the exposure. This procedure we term "logging the grid"; it is unnecessary to repeat the process so long as you use the same position and the same angles. For illustration, you are making the right mastoid exposure and you have rotated the grid to 52° ; for the left mastoid examination you will rotate the grid to 52° in the opposite direction, the patient assuming the same position with the left mastoid to the plate, and repeat the exposure. Figure 6 shows a stereoscopic view of the right mastoid, and Figure 7 is a view of the right mastoid. After the exposure was made the patient was asked to stand aside, the cassette was pushed into position Number 2 and a flash was made of the grid at its stationary position, giving the correct view of grid rotation for mastoid exposures in the double 13° angle.

As an additional aid in securing uniformity of position for duplicating parts on the film, there is, on the dial of the disk, a scale



Fig. 5. The direct postero-anterior view is obtained from a convenient position.

which may be used as a landmark with any point you may arbitrarily select, the glabella, external canthus of eye, tip of nose, angle of mouth, occipital protuberance, vertex, etc. By remembering the numeral (we will say 52) when one is using a double 13° position for the mastoid, it will not be necessary to repeat the logging process. A record of all exposures can be filed for future reference, making it easy to duplicate at any future time.

We might also add that, when this device was finished, it was first mounted on an old dental chair purchased for the purpose. The base was removed from the chair and used as a stand on which to mount the Bucky arrangement, the idea being to permit adjustment for different heights. A swivel chair was used for seating the patient. However, we soon learned that the base of a dental chair with the parts attached allowed too much vibration of the mechanism, and the breathing of the patient was a factor to be

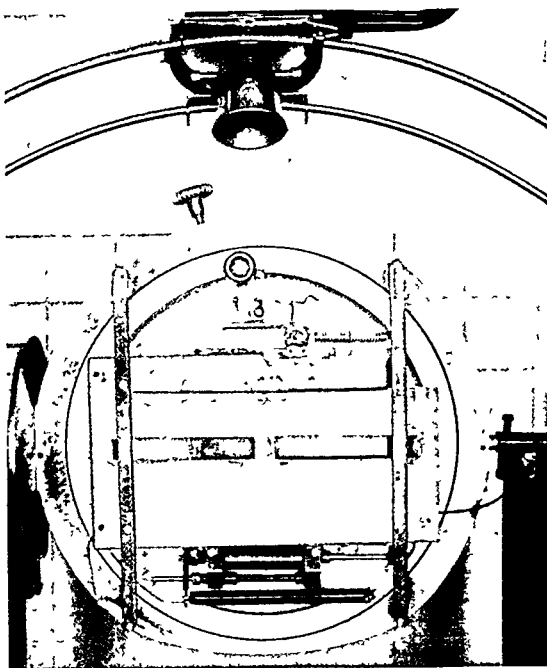


Fig. 3. Back view.

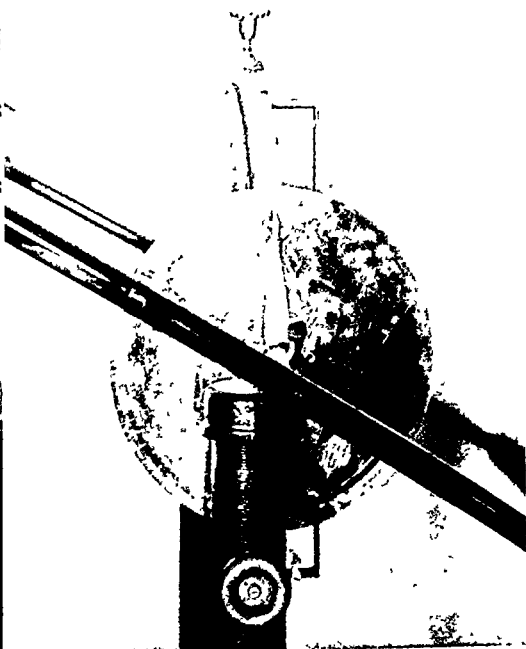


Fig. 4. When the grid is vertical, the large indicating hand on the side of the grid points to 90. This disk is fixed tight to the axis of the orbit. The indicating hand remains in a stationary upright position. When the orbit is tilted forward or backward, carrying the grid, this large indicating dial moves with it. Therefore, the horizontal line, 0, on the dial must, of necessity, follow the tilt of the grid. When the indicating hand as attached to the tube arm is brought to 0 on this dial, the central ray will be brought to the exact vertical position over the axis of the grid.

and bring the tube arm down exactly to the 17° mark below 0. The phrase "to position the patient properly" is of great importance in securing this position.

This arrangement is found very convenient and all work is accomplished with one indicator; at the same time, it releases the patient from the floor, so to speak, with reference to any angle (Fig. 5). The patient here is sitting in a comfortable position, while the head is actually inclined 15° away from the perpendicular plane. At the same time the target of the tube is directly perpendicular to the film, giving us a direct postero-anterior view in a much more convenient position than if the grid were set vertically and the patient compelled to assume a more erect position.

We might also mention that the central ray in any position of the tube always points to the exact center of the film. This technic applies to all positions of the head in which the ordinary flat Bucky grid is found practical. On the other hand, if we desire to

use the numerous tube shifts and angles so often found necessary in the examination of the mastoids, optic foramen, temporomandibular joint, etc., and not found practical on the ordinary stationary grid, we will find that, with the aid of this device, we may conveniently do all head work requiring Bucky technic, dispensing with the interchangeable, or spiral, type of grid.

The method of finding the proper grid angle is simple for any position: when once found, this part of the technic can be dispensed with for similar examinations. Granting that you have never used this device and desire to use it with some position not found practical with the stationary grid.

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reckoned with. We then transferred the Bucky to a more rigid type of stand adjusted to a permanent height of 44 inches from the floor. We reassembled the dental

1 The patient is seated in an upright and comfortable position.

2 The head can be placed and held in position without undue strain.

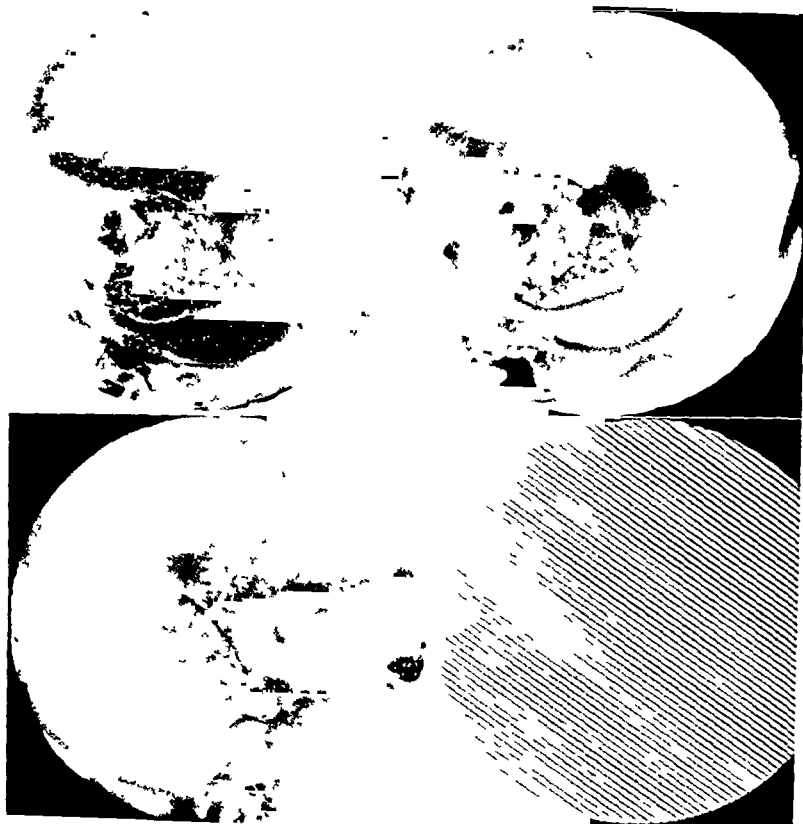


Fig 6 (*top*) A stereoscopic view of the right mastoid

Fig 7 (*bottom*) A view of the right mastoid. After the exposure, the patient is asked to stand aside, the cassette pushed to position No 2, and a flash is made of the grid at its stationary position, giving the correct view of grid rotation for mastoid exposure in the double 13° angle

chair and used it to adjust the height of the patient to the proper position (Fig 5). This we found more convenient in many ways. We can easily stand at the back or side of the patient, and manipulate the chair with one foot while viewing the exact position.

CONCLUSIONS

Some of the advantages of this device are:

3 The tube can be shifted to any desired angle.

4 The central ray is always perpendicular to the center of the film.

5 Two exposures can be made on an 8×10 film, saving time and expense.

6 Stereoscopic shifts in two directions can be made which can be studied with a 75-cent hand stereoscope.

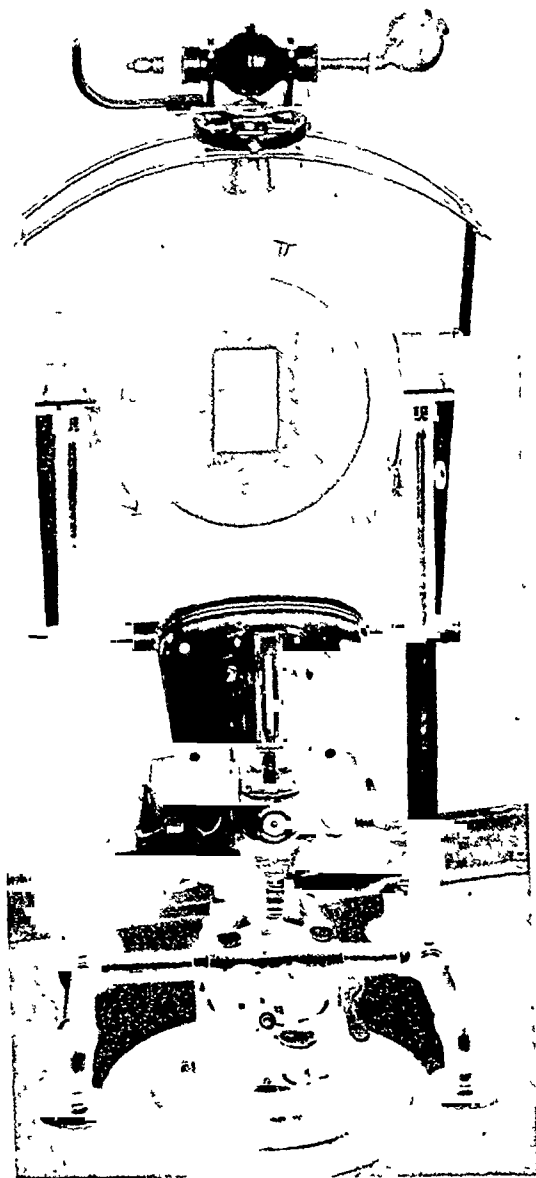


Fig 8 Front view of machine showing leather-covered aluminum disk and general assembly of machine with dental chair hoist.

7. A single Bucky grid adapted to any tube angle, eliminating the spiral or interchangeable grids, is used.

8. The grid may be removed, or the cassette may be placed on the front of the dial, disregarding the grid if desired, still retain-



Fig. 9. A side view of machine with patient in position for mastoid exposure.

ing all the advantages of any other sinus tube stand we know of at the present time.

9. A graduated dial is attached to the axis of the grid, disregarding the floor with reference to the position of the patient.

Since the discovery of the Potter-Bucky grid, its value has been a debatable question; yet to-day no X-ray laboratory is complete without it. That the use of the Potter-Bucky diaphragm, when applied to the examination of the skull, increases the definitive value of a film is a settled question with a large number of roentgenologists. But the theme of this paper has not to do with the value of the Bucky grid but to its adaptation to various angles, with special reference to the examination of the paranasal sinuses.

LEONTIASIS OSSEA¹

By EUGENE FREEDMAN, M.D.

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HYPEROSTOSIS cranii, craniosclerosis, or leontiasis ossea is a rare disease found most often in individuals in the early decades of life. It produces enormous, diffuse hyperostoses, beginning usually in the bones of the face and extending to those of the skull.

The term *leontiasis ossea* was given by Virchow (12). He noted the resemblance to the facies of leprosy and assumed the bony alteration to be of the same nature as elephantiasis of soft parts. Bockenheimer (2), who gives a complete review of the literature up to 1908, pointed out that a marked facial deformity is not always present, that local infectious disease is not a necessary precursor, that it is not similar to elephantiasis, and proposed the designation *diffuse hyperostosis of the face and skull*. The term *leontiasis ossea* is widely applied and can be employed by the rule of good usage.

In leontiasis ossea the cranial and facial bones are more or less markedly thickened, depending upon the stage of the disease. They give the impression of being swollen, but the resemblance to normal bone remains. The inner and outer tables cannot be differentiated. The homogeneous aspect may be interrupted by some scattered patches of soft fibrous looking material and, in rare cases, cystic degeneration of such fibrous patches may be seen.

The bone is vascular, soft, and can be cut away or penetrated easily with a trephine. In later stages, when ossification has advanced, it becomes more firm. The surface of the bone is smooth.

When examined anatomically, the diseased bone presents innumerable apertures, but there are areas in which fewer are seen. Such areas are the remains of the compact tissue. The apertures represent the surface of a cancellous tissue which has taken the place of the original bone and is permeated by a vascular connective or fibrous tissue medulla.

The histology of these forms is the histology of Paget's osteitis deformans. The original bone disappears, and an area much larger than that occupied by it is filled by a vascular and cellular connective tissue, which in places may become fibrous. In this tissue new bone develops, showing in the early stages no lamination, or a lamination produced differently from the ordinary. Around the lamellæ there is a row of spindle-shaped cells, representing osteoblasts. Few osteoblasts are found in the diseased tissue.

Reviewing the literature many cases were found in which, in accordance with Knaggs' (5) findings, the histologic picture was that of Paget's disease, but Boit (1) and others examined specimens of leontiasis microscopically and found the typical appearance of Recklinghausen's osteitis fibrosa cystica characterized by multiple cyst formations. The combination of these two forms also occurred at times.

From the histologic findings, leontiasis ossea can be considered as a localized form of either Paget's osteitis deformans or Recklinghausen's osteitis fibrosa cystica. Because the two diseases are very similar histologically, there is considerable difference of opinion at the present time as to whether Paget's and Recklinghausen's diseases represent different stages or manifesta-

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tions of the same disease or whether each is a distinct entity. Both show fibrous tissue, cell-rich medulla, lacunar resorption, giant cells, osteoblasts, and changed bone lamellations. The differences are mainly clinical and roentgenologic. Osteitis fibrosa starts in childhood and, before the bone changes can be noted, there are aches in the bones, which gradually increase in severity. Pathologic fractures are common but the involvement of the skull is very rare. Paget's disease occurs in middle life and old age and the involvement of the skull is very common. No pathologic fractures occur.

Meyer-Borstel (8) published a case recently which seems to confirm the close relationship of the two diseases. The patient, first examined in 1920 when he was 24 years of age, complained of rheumatoid pain in the left knee, and the roentgenograms showed two small cysts in the patella. A year later almost all the bones showed multiple cyst formation with numerous pathologic fractures. In 1928 the cysts had disappeared, but the bones showed the typical appearance of Paget's disease, including the involvement of the skull, which previously had appeared normal. The author compares the different manifestations of Paget's and Recklinghausen's diseases with the manifestations of a metastatic breast carcinoma, which in some cases produces multiple, sharply defined, osteolytic, cystic destructions in the medullary portion, with severe pain and pathologic fractures. In other cases the metastatic tumors are represented as diffuse, osteoplastic, homogeneous eburnations of almost the entire skeleton with the patient in good physical condition.

It is readily seen from the above that leontiasis ossea is not a pathologic entity, but a clinical picture, the main symptom of which is a leonine face. It begins usually at an early age and one of the earliest signs is nasal obstruction. Trouble with the lachrymal apparatus from stenosis of the

nasal duct is also to be expected. It is occasionally mentioned and, because it may occur before deformity appears, it has in some cases been looked upon as the exciting cause of the disease. It is difficult to determine exactly when the disease starts because the patients report only when the changes are marked.

Among the involved bones the most common are the nasal and zygomatic lower orbit, horizontal ramus of the mandible, and the alveolar processes of the lower and upper jaws. Among the skull bones, the frontal and temporal bones are most commonly involved.

The diseased areas, which are painless, show no evidence of inflammation. The slow progress of the bony changes is characteristic. At times the disease remains dormant for over a period of years and the patients have no subjective symptoms. There are, however, cases which are progressive in character. The process grows in the course of years and there is a constant enlargement in the size of the bones.

In some cases neuralgic pains occur early in the disease, due to the obliteration of the supra- and infra-orbital foramina. In other cases speech and mastication are disturbed. The progressive stages of the disease of the skull bones are serious. Narrowing of the orbital cavity may occur, with protrusion of the eyeball and subsequent disturbance in vision, amblyopia, and finally blindness. If the base of the skull is involved, the cranial nerves may be affected with resulting disturbances of smell, taste, and hearing. Even paralysis of the extremities may occur. In the end-stage, severe headache, delirium, and attacks of cramps may be present. Consequently, the course of the disease is variable. Whereas the mild cases present no other symptoms than the deformity, in others the disease can be fatal through rapid progression. In hogs, apes, cows, horses, dogs, and rats the veterinarian often finds

pathologic changes of hyperplastic nature in the jaw and the bones of the forehead very similar to the human leontiasis ossea.

The etiology of leontiasis ossea is not known, but many theories are advanced.

Knaggs (5) thinks that the most probable cause is a micro-organism. The infection, according to him, travels under the periosteum and sets up an osteitis of the adjacent bony tissue. A sinus infection, infection of the nasal cavity, or an infected tooth apex could be the primary focus. There is, however, no bacteriologic proof that leontiasis ossea is due to a micro-organism. The suggestion of micro-organismal origin is based upon the curious way in which the disease spreads. In Léri and Arnaudet's (6) case, there was a history of a purulent discharge through a fistula of the left side of the maxillary bone with a tremendous bilateral enlargement of the bone. That infection plays a possible rôle is suggested by the fact that at times an entire herd of hogs becomes diseased, and in horses chronic joint changes were found associated with facial changes.

Recklinghausen (9) thought trauma to be an important primary factor of leontiasis because trauma often leads to subsequent new bone production. And in fact, a history of trauma is frequent in the clinical records of the published cases.

Ziegler thinks that the disease is due to a congenital disposition of the periosteum and marrow to grow. There are theories that the disease has something to do with persistent thymus or hypophyseal disturbances. Some autopsied cases, however, did not show changes in the thymus, thyroid, or hypophysis. In some cases heredity can be established as a factor in the etiology of this condition.

The roentgenologic findings are characteristic: Deforming enlargement of the bones, narrowing of the medullary portion

throughout localized areas of the skull and face, secondary narrowing of the foramina; orbits, and sinuses. The details of the bone, however, vary according to the underlying pathologic process, showing either a pagetoid lamellation, with osteoid tissue formation and lacunated areas, or multiple cysts corresponding to Recklinghausen's disease.

The roentgenologic diagnosis can be made before clinical symptoms appear. Although it is generally recognized that the condition is localized to the facial bones and to the cranium, Ruppe (10) found that the first and second cervical vertebræ, and Knaggs that the head of the fibula, may be also involved, indicating that the lesion is of more generalized character.

Malignant tumors resemble leontiasis ossea only in the beginning because bone tumors grow very rapidly and the roentgenograms show bone destruction. Syphilis, which as a rule produces a diffuse, but never as marked, hyperostosis, occurs more often in the bones of the skull than of the face. Also there are usually other signs of hereditary syphilis or syphilitic changes. Elephantiasis and lymphangioma are easily differentiated.

Osteomas form circumscribed, well defined bony tumors, which are at times connected by a stem to the bone from which they originate. They consist of eburnated and not of spongiose or fibrous tissue.

Acromegaly starts at the end of the growing period, first with the extremities, then the face. Although acromegaly can produce the same kind of thickening of the facial and cranial bones, with obliteration of the paranasal sinuses, the differentiation is easy. In acromegaly, not only the bone tissue, but all the tissues of the face, take part in the excessive growth, the lips and tongue being also markedly enlarged.

The prognosis in leontiasis ossea is favorable when the disease shows a slow growing tendency. Progressive cases are hopeless. If the disease is well localized in an early

stage. good results may follow operation. Cases are reported, however, in which a rapid growth occurred after operation. Consequently, it is hard to determine whether or not the patient should be operated upon. If the surgeon is forced to operate on account of the pain and disfiguration, it can be done on facial bones, but the skull bones should never be touched.

CASE REPORT

P. H., 57 years old, white, male, was admitted to Cleveland City Hospital on May 21, 1928, in a stuporous condition. He had suffered from restlessness, nervousness, and general irritability for years. About three weeks previous to the present examination, he was told by his doctor to take "bromidia." The day before admission the patient took the equivalent of 270 gr. of chloral hydrate within a period of 17 hours. He passed into coma at home and was sent to the hospital by his physician.

Following an injury to the right cheek in boyhood at the age of 12, a swelling of the right cheek bone was noted. This had slowly and painlessly continued to enlarge. The increase had been very slow in the preceding decade. The wife stated that the patient had no venereal diseases or serious illness, but that he was addicted to alcohol and had attempted suicide on several occasions. The patient had always been nervous, but had become more irritable in the few months preceding the present illness. Amblyopia had been present of late.

The clinical examination revealed an irregular nodular enlargement of the right zygomatic arch, hard palate, maxillary bone, and right half of the mandible (Fig. 1). The area of over-growth was not tender, nor was the overlying skin inflamed. There was a drooping of the right lid and right angularis iris. Tongue and fauces were negative. The urine showed nothing of in-

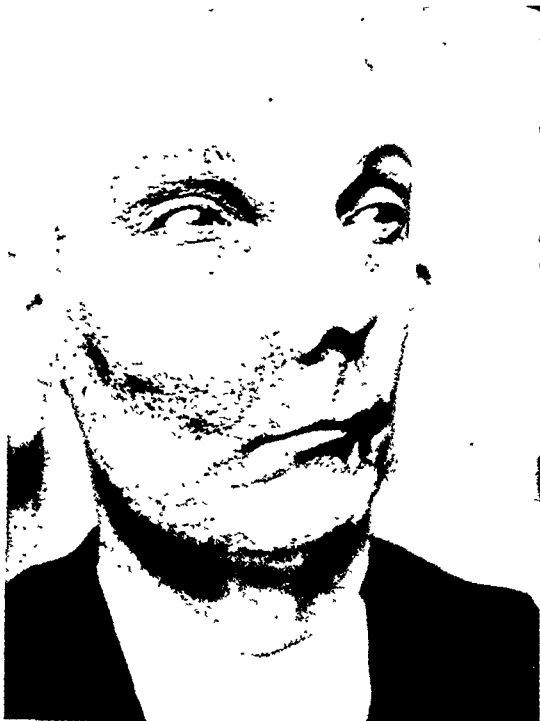


Fig. 1. Photograph showing the marked, irregular enlargement of the right zygoma, frontal, and maxillary bones and of the mandible. The mouth is drooped, the nose is tilted to the left, and the outer circumference of the orbital cavity is narrowed.

terest. The white blood count was 8,000; the blood Wassermann was negative.

Roentgenograms (Figs. 2 and 3) showed the right frontal bone and the bones of the right side of the face, including the right mandible, to be tremendously enlarged. The process extended into the right temporal and sphenoidal bones, and the floor of the anterior cranial fossa was involved. The frontal bone in the region of the sinus measured 5 cm. in thickness. The enlarged bones showed multiple small and irregular areas of diminished density, surrounded by irregular areas of new bone production, giving a flabby, cottony appearance. There was marked narrowing of the right orbit and complete obliteration of the right frontal maxillary and ethmoidal sinuses, due to the overproduction of bone. The bone changes were both osteoclastic and osteoplastic in



Fig. 2. Postero-anterior view of the skull and face. The right maxillary, frontal, and zygomatic bones and the mandible retain their original form, but are tremendously enlarged. The frontal and maxillary sinuses, the ethmoidal cells, and the nasal cavity are all obliterated on the right. The right orbit is narrowed. There is considerable new bone formation throughout, with lacunar areas of bone destruction. The destructive changes are most marked in the mandible.

character. The roentgenologic appearance was very suggestive of Paget's disease.

The patient left the hospital at the end of three days and was not seen again.

CONCLUSIONS

1. Leontiasis ossea is a clinical descriptive term and not a pathologic entity.
2. The histologic picture is either that of osteitis deformans (Paget) or of osteitis cystica (Recklinghausen).
3. The case reported showed the roentgenologic appearance of osteitis fibrosa (Paget's disease).



Fig. 3. Lateral view of the skull and face showing the unusual thickness of the frontal bone. The process involves the sphenoid bone also. The sphenoid sinus is almost completely obliterated. Note the marked protuberance of the right maxillary bone.

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DISCUSSION

DR. FREEDMAN (opening remarks): This is not a histologically proven case. Unfortunately, as the patient was not co-operative, we were unable to obtain a biopsy on him, nor was he willing to return for further check-up. But I think the roentgenologic appearance, clinical history, and facial deformity are sufficient proof to consider this a typical representative of leontiasis ossea.

One of the main reasons that we roentgenologists do not see this type of lesion more often is that the disease commonly starts in the region of the maxillary sinus and alveolar process, and the dental surgeons are consulted first. Although the disease is considered a rare one in the medical literature, I encountered in Cleveland recently three additional cases, which had been seen and roentgenographed by dentists.

DR. LEON T. LEWALD (New York): I am much interested in this presentation because of its possible relationship to Paget's disease. My impression is that, although it certainly has many of the characteristics, it is somewhat different in nature from Paget's disease.

I have studied 69 cases of the latter and, curiously enough, there is not a single one in that group which shows the peculiar involvement of the bones of the face that is seen in leontiasis. Four cases do show marked involvement of the superior maxilla, and one case presented a marked involvement of the inferior maxilla, but none of them shows extreme involvement of all the bones of the face.

Did I understand Dr. Freedman to say that no other bones of the body are involved in these reported cases?

DR. FREEDMAN: Yes, other bones of the body have been found to be involved also. Ruppe found the involvement of two vertebral bodies and Lawford Knaggs found the involvement of the fibula. The involvement of the additional bones of the skeleton are most often of the pagetoid type.

DR. ROBERT J. MAY (Cleveland, Ohio): The pathologic process noted in leontiasis ossea is a marked thickening and, later in the

disease, a marked increase in the density of the bones of the face and skull. The cranial bones often attain a thickness of 3 cm. or more. Such a skull may weigh 10, or more, pounds.

Knaggs describes two forms: (1) a creeping periostitis which, he says, is due to some sort of infection, and (2) diffuse osteitis due to toxemia.

Schüller states that both forms of the disease are present in most cases. Atypical forms of the disease may involve one, or several bones, or only a small part of one bone.

In the first form, the periostitis begins in the nasal fossæ, spreading to the accessory nasal sinuses, orbits, and bones of the face and skull. The spaces gradually become filled with new bone, the decreased orbital capacity causing bulging of the eyeballs. The foramina are narrowed and the nerves, vessels, etc., emerging through them, are compressed. Headache, blindness, neuralgia, convulsions, and the other symptoms are due to pressure on the structures as they emerge from the foramina and from the increased cranial pressure due to the decrease in the size of the cranial cavity.

Knaggs believed that infection or toxemia causes the disease. Other writers have suggested syphilis as a rather infrequent cause. Friederich cites several cases of Hodgkin's disease in which he found similar bone deformities. Trauma and disturbed internal secretions are also regarded as etiological factors. The histologic changes in leontiasis ossea, osteitis deformans, and osteitis fibrosa cystica are the same and it is probable that all three are different manifestations of the same disease.

Surgical and medical treatment are disappointing. I wish to cite briefly one case with osteitis fibrosa cystica limited to the frontals and sphenoids which improved under roentgentherapy.

Five years before the patient presented himself for examination, he had suffered a fracture of the right side of the skull, the exact site of which was not known. For two years he had noticed a painless swelling of the right

(Continued on Page 55)



Fig. 2. Postero-anterior view of the skull and face. The right maxillary, frontal, and zygomatic bones and the mandible retain their original form, but are tremendously enlarged. The frontal and maxillary sinuses, the ethmoidal cells, and the nasal cavity are all obliterated on the right. The right orbit is narrowed. There is considerable new bone formation throughout, with lacunar areas of bone destruction. The destructive changes are most marked in the mandible.

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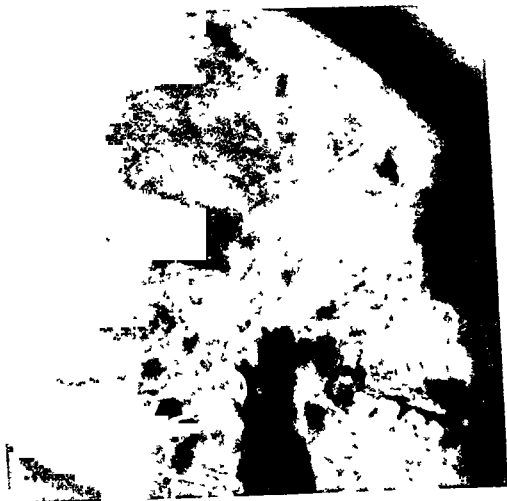


Fig. 3. Lateral view of the skull and face showing the unusual thickness of the frontal bone. The process involves the sphenoid bone also. The sphenoid sinus is almost completely obliterated. Note the marked protuberance of the right maxillary bone.

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thin, soft glass therapy tubes, although not to the same extent as with the newer, thick, pyrex tubes. The hard glass not only makes for greater change during the heating-up period, but the thicker glass which is used causes the heating-up period to last longer, and the better electrical operation of the tube causes it to be operated at full voltage sooner after a cold start. With the older, soft glass tube, the K.V.P. may rise as much as 10 K.V.P., or, in some instances, even drop 3 or 4 K.V.P., but the r output always drops—from 0 to 7 per cent. Stable conditions are reached in approximately five minutes.

The phenomenon that has been described apparently occurs with operation on any type equipment except constant potential and polyphase circuits that are nearly constant potential. On constant potential equipment, no change in K.V.P. or r output occurs during the heating-up period; and, as far as outward results are concerned, the phenomenon does not take place. As a matter of fact, however, the same changes take place inside the tube that are responsible on other circuits for the outward changes that have been discussed.

THEORY

Although the facts reported may seem unintelligible or even contradictory, fortunately an explanation can be given that makes them understandable. It is necessary first, however, to discuss a tube characteristic which, on the surface, may not seem related to the facts under consideration.

In any X-ray tube, not alone the air-cooled type, the bulb, or envelope, surrounding the anode and cathode is bombarded by electrons from the cathode. If there were no leakage of electrons from the bulb to the positive electrode of the tube, this bombardment would stop almost instantly when the bulb reached a negative potential sufficient to repel further electrons. A certain amount

of leakage always occurs because glass, like every other insulator, has a small, but in this case important, electrical conductivity both over its surface and through its volume. As a result, there is a constant bombardment of electrons on the glass just sufficient to equal the leakage and the bulb takes on such a negative potential with respect to the anode that this equilibrium exists.

The amount of current that passes from cathode to anode potential by way of the bulb is negligible in itself, inasmuch as it amounts to only a current of the order of micro-amperes, or less. The fact, however, that the bulb is charged to a negative potential with respect to the anode, and can act as a grid in influencing the main electron flow between cathode and anode, is potentially important. *Potentially* important, because it is important only when its influence is a variable, as is the case in the air-cooled therapy tube.

Variability in grid action of the bulb in an air-cooled therapy tube while the glass is rising in temperature is a result of electrical conductivity change paralleling the temperature change, with consequent equilibrium change between leakage and bombardment and, therefore, changed bulb potential. In other words, with rising temperature there is more conductivity, the bulb becomes less negative, and grid action is reduced.

It remains to be shown what connection variable grid action of the bulb can have with the variable r output and K.V.P. phenomenon.

Ordinarily electron flow in a hot cathode X-ray tube is determined almost entirely by filament emission—the space charge voltage necessary to pull the electrons across being small compared to the operating voltage. The effect of the grid action is to increase considerably the space charge voltage so that the electron flow is to a greater extent influenced by tube voltage.

TRANSIENT K.V.P. AND r OUTPUT FROM AN AIR-COOLED THERAPY TUBE

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IT is the purpose of this paper to call attention to a little known X-ray tube phenomenon which, while possibly not very important once it is understood, can cause considerable bewilderment if it is encountered without a knowledge of its explanation. The phenomenon takes place in any air-cooled therapy tube during the heating-up period of operation (while the anode and glass of the tube are coming to a steady state of temperature). Even though the primary voltage and milliamperage, or peak kilovoltage and milliamperage, are kept constant, it makes itself known by a changing r output. Since air-cooled therapy tubes are now developed to the point at which they can be used at full voltage without first going through a long warming-up process, the transient during this period, unless taken into consideration, can be a source of error in dosage large enough to be significant with present-day methods of measurement.

DATA

Data on both kenotron and mechanically rectified equipment show that operation of an air-cooled therapy tube at constant primary voltage and milliamperage during the heating-up period gives a change in kilovoltage which may amount to a rise of as much as 12 K.V.P., and a drop in r output which may amount to 15 per cent (as measured through 0.5 mm. of copper and 1 mm. of aluminum). The changes, which are of the same general order of magnitude on either equipment, are influenced by a number of factors: the temperature of the glass at the start, the milliamperage, the amount of circulation of air around the tube,

the tube used, the equipment, and the line voltage wave shape. It will be noted that, for constant primary voltage, the r output drops, even though the K.V.P. rises. Attention is called to this seeming contradiction to point out that the r drop would be even greater were the K.V.P. held constant during this period.

The changes mentioned above occur to a greater or lesser extent with any tungsten anode air-cooled therapy tube. Different type tubes from various manufacturers have been tried. It might be noted at this point that the transient phenomenon does not occur with water-cooled type therapy tubes. In this type, heat is taken out through the water, the glass envelope does not change appreciably in temperature, and K.V.P. and r output are constant from the start. It should also be emphasized that the transients in the air-cooled tubes last only while the glass envelopes of the tubes are coming up to a steady temperature. After this is reached, the K.V.P. and r output are constant reproducible quantities.

With a thick pyrex glass tube, the transient period in general covers the first seven to ten minutes of operation from a cold start. It may last longer, if the tube is operated at low current, 2 or 3 ma., for instance. In any case, the changes take place more rapidly in the first few minutes so that, after five minutes, the tube voltage is not likely to rise more than 4 K.V.P. or the r output drop more than 6 per cent—if this much. The data given apply to operation from a cold start. If the tube is warm to start with, as it would be if operated within the preceding 15 minutes, the changes given will be cut in half—or less.

The transient is noticeable with the older,

velope, or bulb; (5) increased tendency for the tube current to be controlled by filament emission, rather than grid action space charge; (6) flatter-topped current wave shape, because the current is more independent of voltage; (7) changed voltage wave shape, usually in the direction of a more peaked wave; (8) decrease in filtered r output. Any increase in K.V.P., as far as influencing filtered output is concerned, is more than counteracted by the drop in peak milliamperage and decreased length of time during which both are reasonably high.

No attempt will be made here to prove rigidly the above explanation. It may be interesting, however, to mention a few additional facts bearing on it.

If the bulb of an air-cooled therapy tube, before being operated, is heated mechanically by means of an oven or gas flame to approximately the steady running temperature, no transient is present from the start of operation, thus showing that temperature change is the controlling factor in the transient.

Those who have used both the older, lime glass, water-cooled therapy tube and newer, thick, pyrex glass tube have probably noticed that for the same primary voltage the hard pyrex glass tube gives a lower kilovolt peak. The reason for this lies in the fact that the hard glass has a lower glass conductivity than the soft lime glass. The bulb, therefore, charges up to a more negative potential, grid action is more pronounced, the current wave shape more peaked, and the

voltage wave shape flattened. The difference in current wave shape between the two types of tubes is observable by means of stroboscopic analysis of a neon glow tube in series with the X-ray tube, or by oscillographic study.

In a kenotron, any grid action of the negatively charged walls is a very serious thing, because the tube voltage drop, which in this case is entirely determined by the space charge voltage, must be low and reproducible. It was this consideration that led to the development of the cylindrical anode type kenotron in which the anode completely shields the anode-cathode space from any possible grid action of the glass bulb.

SUMMARY

During the heating-up period of operation of an air-cooled therapy tube, the K.V.P. and r output are almost certain to be variable quantities.

This is true for operation on all equipment except constant potential.

The tube voltage may rise for constant primary voltage as much as 12 kilovolt peak. The r output always drops—in some cases as much as 15 per cent.

With a thick, hard glass therapy tube, the transient period covers the first seven to ten minutes of operation from a cold start.

The explanation for the above is wave shape change caused by decreasing grid action of the bulb of the tube as the glass envelope rises in temperature.

On any rectified circuit, where the tube voltage pulsates from zero to a maximum, the result is a slightly more peaked current wave shape than would otherwise be the case. The change in current wave shape, in

influenced. At the most, all that can occur is that a slightly higher filament emission may be necessary for a given tube milliamperage than would otherwise be the case.

With this background, the sequence of

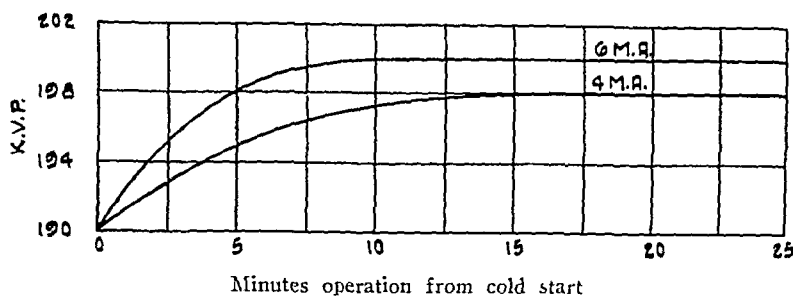


Fig. 1. K.V.P. transient from a thick pyrex glass air-cooled therapy tube operating on either a kenotron or mechanically rectified equipment at constant ma. and primary voltage.

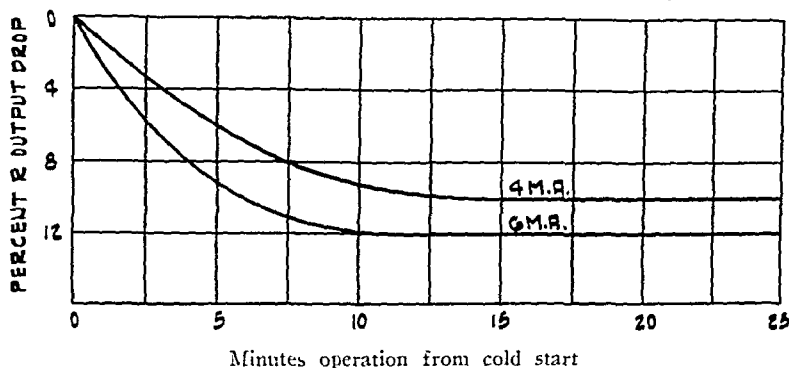


Fig. 2. r output transient (0.5 mm. Cu—1 mm. Al filter) from a thick pyrex glass air-cooled therapy tube operating on either a kenotron or mechanically rectified equipment at constant ma. and primary voltage.

turn, means that, for a given average (meter reading) milliamperage, the current useful in producing the hard X-rays (that pass through 0.5 mm. of copper) is increased. In addition, a more peaked current wave shape on practically all circuits gives a flatter topped voltage wave shape, that is, a voltage wave of lower peak value but of higher effective value.

On constant potential equipment, current wave shape is, of course, fixed and cannot be

events that results on pulsating voltage circuits in an increase in K.V.P. and a lowering in r output during the heating-up period can be outlined as follows:

Rising glass temperature gives (1) increased conductivity of the glass; (2) changed equilibrium between electron leakage and bombardment of the tube envelope; (3) less negative voltage on that portion of the envelope surrounding the anode-cathode space; (+) decreased grid action of the en-

than ten minutes will start decomposition of films, and that ignition of X-ray films by direct contact with steam pipes takes place readily. However, a jet of live steam at 75 pounds pressure did not start combustion when it was directed on envelopes containing films. Cellulose acetate, or "safety films," did not decompose under the conditions under which nitrocellulose films did. These results of the Chemical Warfare Service were corroborated by Braidech and Saylor (+), who found that films held in contact with a 100-watt bulb ignited in from two to seventeen minutes.

The reports of other investigators clearly show that both carbon monoxide and the oxides of nitrogen are evolved in large quantities from the decomposition of nitrocellulose films. An analysis of the gaseous products of decomposition of photographic films was made by Hall and Snelling (2). Their results are as follows:

	A.— In vacuo Per cent	B.— In pleno Per cent
Walter soluble.....	3.7	0.7
Nitrogen dioxide (N_2O_2).....	28.5	
Carbon dioxide.....	7.3	7.7
Carbon monoxide.....	26.3	41.2
Hydrocarbons	0.7	3.1
Nitrogen	31.5	26.3
Oxygen		2.1
Hydrogen		18.9

The results obtained by Dr. Veazey (+) from his analysis of the gases obtained from the decomposition of nitrocellulose X-ray films are as follows:

	A.—Insufficient air for complete combustion Per cent	B.—Atmosphere of carbon dioxide Per cent
Nitric oxide.....	35.6 34.0	58.2 60.9
Carbon monoxide	34.0 35.2	38.3 36.2
Hydrocyanic acid..	0.86 1.0	Residue 3.5 3.0

In a separate determination, 1.3 per cent of hydrocyanic acid was obtained.

The Chemical Warfare Service summarizes the results obtained from the flameless decomposition of nitrocellulose X-ray film, separated by paper, as follows:

	Per cent
Nitrogen dioxide ($NO_2(N_2O_4)$)....	6.9– 8.9
Nitric oxide (NO).....	1.4– 8.2
Carbon monoxide (CO).....	47.4–59.1
Oxygen	None
Carbon dioxide	21.3–24.5
Hydrogen	0.9– 3.2
Methane	1.0– 2.7

Olsen, Brunjes, and Sabetta (5) decomposed uncoated nitrocellulose X-ray film in an atmosphere of gas obtained from a previous experiment, obtaining the following results:

	Per cent
Carbon dioxide	14.8
Carbon monoxide	34.1
Hydrogen	0.4
Nitrous fumes	38.0
Hydrocyanic acid	0.23
Methane	2.4
Nitrogen	10.7

Few analyses have been made on the gases evolved from burning cellulose acetate films, undoubtedly due to the fact that their fire hazard is no greater than that of other cellulose material, such as wood or paper. There is, moreover, little danger of poisonous gases being evolved from them. If the films are burned in a limited supply of oxygen, carbon monoxide will undoubtedly be present, as it is formed when wood or paper are burned under such conditions. Olsen and his co-workers obtained 42 per cent and 49 per cent of carbon monoxide from uncoated cellulose acetate films burned in an atmosphere of nitrogen, and 34.4 per cent from cellulose acetate film with the gelatin coating. When the same films were burned in an excess of air, from 5.3 per cent to 7.9 per cent of carbon monoxide was found. When ordinary newspaper was burned under the same conditions, 38.1 per cent of carbon monoxide was obtained in an atmosphere of nitrogen, and 6.2 per cent in an excess of air.

In view of the work of other investigators, Dr. H. B. Podlasky thought it might be advisable to limit this investigation to the

AN INVESTIGATION OF THE GASEOUS DECOMPOSITION PRODUCTS OF X-RAY FILMS¹

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THE original purpose of this investigation² was to determine the decomposition temperature of nitrocellulose X-ray films and the toxic gases evolved from decomposing nitrocellulose and cellulose acetate films. The analysis of the gases was limited in this work to the determination of their hydrocyanic acid content. The concentrations of the other toxic constituents, namely, carbon monoxide and the oxides of nitrogen from nitrocellulose films and carbon monoxide from cellulose acetate films, have been well established by other investigators.

The base of a nitrocellulose X-ray film consists of a mixture of nitrocellulose and camphor similar to celluloid. The camphor imparts plasticity to the mixture. The base of the film is covered on both sides by a thin layer of gelatin impregnated with silver bromide. The explosiveness of nitrocellulose is in direct proportion to the degree of nitration of the cellulose. In films the nitrogen content of the nitrocellulose is about 11.7 per cent, whereas it is as high as from 12.4 to 13.5 per cent in explosives such as guncotton and smokeless powder (1). Films in which the nitrocellulose base is replaced by cellulose acetate are called "safety" films, because the cellulose acetate is stable at temperatures at which nitrocellulose decomposes.

Celluloid burns only when brought in contact with a flame (2). Flameless decomposition will take place, however, if a suffi-

ciently high temperature is attained, in which case the celluloid decomposes with the evolution of large quantities of gases. According to Worden (2), gases are given off which form explosive mixtures with air. These gases, the products of incomplete combustion, are formed in a limited supply of oxygen. They consist mostly of carbon monoxide, nitric oxide, methane, and hydrogen, and combination with oxygen takes place when they come in contact with air.

Although nitrocellulose at room temperature will not decompose to the point of combustion, some deterioration takes place. Worden says that nitrogen peroxide is liberated when nitrocellulose is stored. Farmer (3) explains the decomposition of nitrocellulose as follows: "A catalytic decomposition can take place in the presence of nitric peroxide. It occurs in the absence of moisture and accelerates itself autocatalytically. It consists of an internal oxidation of the nitric ester, aided by atmospheric oxygen, which re-oxidizes nitric oxide evolved by the nitrocellulose to the nitric peroxide. This is absorbed by the nitrocellulose and causes further decomposition."

Experiments undertaken by the Chemical Warfare Service (1), in its investigation of the conditions incident to the disaster at Cleveland, show that "X-ray film, if stored in large quantity, will decompose if subjected to a temperature of 100°C. or higher. The decomposition point for periods of heating not exceeding several hours is near 135° C. At higher temperatures, the decomposition becomes more and more rapid and takes place within one minute or less at about 160°-170° C." It was also found that contact with an electric light bulb for less

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

²The experimental work herein reported was done under the direction of Dr. Herbert Heinrich, of Marquette University, whose helpful suggestions have proved invaluable. Appreciation is extended to the American Medical Association for its grant, and to the Wisconsin Radiological Society for its help in defraying expenses.

ice, however, did not find any hydrocyanic acid liberated from small amounts of film. In an analysis of the gases liberated from 16 pounds of film, separated by paper, 0.014 per cent of hydrocyanic acid was found. This amount is "negligible from a toxicity viewpoint compared to the amounts of carbon monoxide and the oxides of nitrogen found in the same samples." The analyses made, however, were not on concentrated fumes, but on fumes which were more or less diluted with air. Brown (10) does not mention hydrocyanic acid as one of the gaseous products of the decomposition of X-ray films. "Popular Science Monthly" (11) states that blood tests on the victims of the Cleveland disaster showed effects of hydrocyanic acid. Olsen and his co-workers obtained 0.23 per cent of hydrocyanic acid from uncoated nitrocellulose film decomposed in an atmosphere of gas from a previous experiment.

As the gelatin used in the coating of films is a nitrogenous substance, it appears possible that hydrocyanic acid might also be liberated from cellulose acetate films. Olsen and his co-workers obtained 0.75 per cent of hydrocyanic acid from a cellulose acetate film decomposed in an atmosphere of nitrogen. They obtained 0.4 per cent from the same film after the gelatin coating had been removed. An analysis by the Kjeldahl method on this film showed that 0.34 per cent of nitrogen was present. They did not obtain any hydrocyanic acid, however, from a different sample of uncoated cellulose acetate film.

STABILITY TESTS

Experiments were performed to determine the decomposition temperature of nitrocellulose X-ray films. A hot air bath was made by placing a large pyrex tube, 2.3×20 cm., in a beaker containing hot paraffin. A small piece of film was fastened directly on the bulb of a thermometer, which was

then suspended in the tube. In general, it might be said that a small piece of film will decompose at about 150° C.; wide variations from this temperature, however, were obtained by varying the manner of heating. It was possible to decompose the film at temperatures as low as 70° C. and 65° C. by suddenly subjecting it to a very great heat. This was accomplished by plunging the tube containing the film and the thermometer, which were all at room temperature, into the hot paraffin bath, which was at a temperature of about 250° C. The film decomposed in from 30 to 40 seconds; that is, it took that length of time for the temperature of the film to be raised from room temperature to the temperature of decomposition, in this case from 65° to 70° C. (The possibility of these low temperature readings being partly due to the lag of the mercury in the thermometer was ruled out by tests to ascertain the speed at which the mercury thread could travel. It was found that, when the thermometer was plunged into the hot paraffin bath, the mercury rose from room temperature to 70° C. in 1.4 second.) On the other hand, if the film were heated very slowly, at the rate of about one degree a minute, a temperature of 250° C. could be reached without sudden decomposition occurring. However, in this experiment the film became black, brittle, and swollen. A small piece of film placed in contact with a 50-watt electric light bulb decomposed in from one and one-half to seven minutes. No perceptible difference could be found between the decomposition temperature of a film eight years old and of a recently used film.

It was thought desirable to test the stability of cellulose acetate films. Film, weighing 153.65 gm., cut into pieces from two to three inches square, was placed in a large desiccator. The latter was kept in an electric oven at approximately 50° C. for three months. At the end of that time the

possibility of hydrocyanic acid being evolved in toxic quantities. The instantaneous character of some of the deaths at the Cleveland Clinic, mentioned by Dr. Nichols at a meeting of the Radiological Society, suggested to Dr. Podlasky the possibility that hydrocyanic acid might have been responsible or partly responsible for these deaths.

Comparison of the lethal doses of carbon monoxide, of the oxides of nitrogen, and of hydrocyanic acid is rather difficult due to the difference in their action. According to Henderson and Haggard (6), "Nitrous fumes are the most insidious of all of the irritant gases." Little discomfort is experienced at the time of exposure, but several hours later, sometimes as long as 24 hours afterward, edema of the lungs develops and the individual dies.

Carbon monoxide and hydrocyanic acid are asphyxiant gases (6). Hemoglobin has a strong affinity for carbon monoxide, in fact, three hundred times its affinity for oxygen. Hence, exposure to carbon monoxide results in a carbon monoxide hemoglobin being formed. Thus, the oxygen-carrying power of the blood is reduced, resulting in asphyxia. Hydrocyanic acid produces asphyxia in a different manner. It is a protoplasmic poison acting directly on the cells, interfering with tissue or internal respiration. In severe asphyxia, unconsciousness develops at once, and the individual falls as though struck by a blow on the head. If the asphyxia continues, he dies in a few minutes.

Henderson and Haggard give the following fatal concentrations of the three gases:

Carbon monoxide—1,500–2,000 parts per million are dangerous for an exposure of one hour.

4,000 parts per million, and above, are fatal in exposures of less than one hour.

Nitrous fumes—117–154 parts per million are dangerous for a short exposure.

240–775 parts per million are rapidly fatal for a short exposure.

Hydrocyanic acid—120–150 parts per million are dangerous in from thirty minutes to one hour.

3,000 parts per million are rapidly fatal.

Hydrocyanic acid, therefore, is considerably more toxic than carbon monoxide, although less so than the oxides of nitrogen. Immediate deaths are usually attributed to carbon monoxide rather than the oxides of nitrogen. Irvine (7) says, "Nitrous fumes never, in our experience of ordinary gassing accidents, produce partial or complete unconsciousness at the time of exposure as does carbon monoxide, although they may do so if present in massive amounts, and cases of rapid deaths from the concentrated fumes of burning explosives may be partly due to this cause."

Statements found in the literature indicate that hydrocyanic acid may be formed from the combustion of nitrocellulose. Worden says that a little hydrocyanic acid is evolved when celluloid is heated in the absence of air, or in an insufficient supply of air. Brunswig (8) says, "The products of the explosion of nitrocellulose contain . . . in cases of incomplete transformation, nitrogen dioxide and hydrocyanic acid." Hamilton (9) quotes Kockel as saying, "Eight deaths in a burning celluloid factory in Leipzig in 1900 were due to fumes of hydrocyanic acid." Kockel obtained 0.05 gm. of hydrocyanic acid from 5 gm. of burning celluloid. Others (6) also state that hydrocyanic acid is evolved when celluloid is burned.

There appears to be some difference of opinion as to whether or not hydrocyanic acid might have been evolved in toxic quantities in the disaster at Cleveland. Dr. Veazey (4) obtained 0.86 per cent and 1 per cent of hydrocyanic acid in his analyses made with insufficient air for complete combustion. As 0.3 per cent is rapidly fatal, the concentrations he found are in excess of the lethal dose. The Chemical Warfare Serv-

smaller amounts were obtained. Hydrocyanic acid reacts quantitatively with silver nitrate to form a white precipitate of silver cyanide (12). After all of the gas had bubbled through the silver nitrate solution, the latter was titrated with a standardized solution of potassium sulphocyanate, ferric ammonium sulphate being used as an indicator. The amount of hydrocyanic acid present in the gas could then be calculated from the quantity of precipitated silver cyanide obtained.

In former experiments (13) the gas was caused to bubble through the silver nitrate solution by allowing kerosene to drip into the gallon bottle, thus displacing the gas and forcing it through the solution. The kerosene used had been thoroughly shaken with concentrated sulphuric acid until the latter no longer appeared yellow after standing in contact with the kerosene for five minutes. This was done to remove the unsaturated hydrocarbons, as it was believed that, in their absence, hydrocyanic acid would not be taken up by the kerosene. After a number of combustions had been made, two blank determinations were made with the kerosene by allowing it to displace air, instead of gas, from the gallon bottle. A negligible amount of silver cyanide was formed in the silver nitrate solution. After the kerosene had been used for some time longer, another blank determination was made. This time an appreciable amount of precipitate was obtained. It was, therefore, thought advisable to check the kerosene by using some other method of bubbling the gas through the silver nitrate solution. This was done by drawing a current of air through the gallon bottle with a suction pump. In another experiment, nitrogen was admitted into the gallon bottle containing the gas until atmospheric pressure was obtained. The contents of the bottle were then removed by suction. Much larger amounts of silver cyanide were obtained in

these experiments than in corresponding determinations in which kerosene was used. It was concluded that a large percentage of the hydrocyanic acid was taken up by the kerosene, and that the use of the latter would have to be abandoned. In all subsequent experiments the gas was drawn by evacuation from the gallon bottle through the silver nitrate solution. The pressure of the small amount of residual gas, which could not be removed by suction, was calculated from the manometric reading, and the amount of silver cyanide precipitate, which would have been formed from the entire volume of gas, could thus be calculated.

A qualitative test for the identification of a cyanide was made on the precipitates formed in the silver nitrate solution. The test used depends on the formation of a blood-red color due to ferric sulphocyanate. The test is performed as follows: a drop of yellow ammonium sulphide is added to a small amount of precipitate and evaporated to dryness. A drop of water is then added, followed by one of ferric chloride. In the presence of silver cyanide a blood-red color is obtained. The test was positive for all precipitates.

In the combustion of the nitrocellulose film in a vacuum, the following procedure was used: 12 gm. of film, cut into pieces about two inches square and made into a bundle, were placed in the two-liter, round-bottom flask, and the apparatus was evacuated. It was impossible to remove all of the air. A residual pressure varying from 10.5 to 16.5 mm. remained. The flask was then heated with a Bunsen burner until fumes appeared, after which the flame was removed, and the flameless combustion proceeded without external aid. After the apparatus had cooled to room temperature, the manometer was read and the stop-cock shutting off the gallon bottle from the rest of the apparatus was closed. The latter was again evacuated and a second combustion made

films had not lost any weight. After one week, and again after three months, the air over the film was bubbled through a standard silver nitrate solution by drawing a current of air through the desiccator. A pre-

analysis. A manometer was placed between the round-bottom flask and the gallon bottle. Heat was applied to the nitrocellulose film with a Bunsen burner until fumes arose from the film, after which the burner was

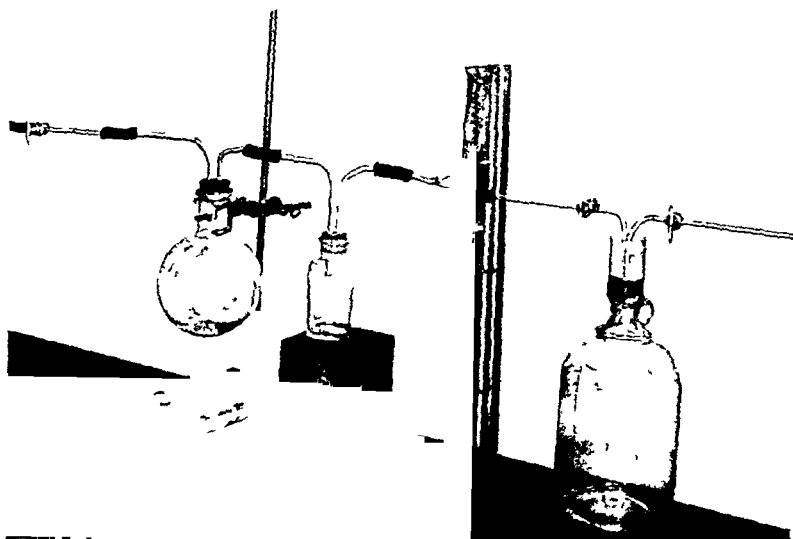


Fig. 1. Apparatus used for the combustion of film.

cipitate of silver cyanide was not formed in the silver nitrate solution.

HYDROCYANIC ACID

Experiments were performed to ascertain if hydrocyanic acid is evolved when nitrocellulose and cellulose acetate films are decomposed in a limited supply of oxygen, and if the amount formed varies with the amount of available air. Combustions were, therefore, made in a vacuum and at atmospheric pressure. Experiments were performed on films with and without the gelatin coating.

Combustions were made in a two-liter, round-bottom flask fitted with two stop-cocks (Fig. 1), one leading to a suction pump and the other connecting with a gallon bottle, which was used to collect the gas for

removed and the flameless combustion proceeded without external aid. As cellulose acetate films can be decomposed only by keeping them at a high temperature, the flask was heated with an electric hot plate. This was done so that the same amount of heat could be applied in all experiments and comparable results obtained. After the combustion, the system was allowed to cool until the pressure exerted by the gas remained constant. The manometer was then read, and the stop-cock shutting off the gallon bottle from the rest of the apparatus was closed. The gas was bubbled through two test tubes, each containing 10 c.c. of standard silver nitrate solution acidified with nitric acid. A 0.1 normal solution was used in the experiments in which a large amount of hydrocyanic acid was found, and a 0.05 normal solution in those in which

smaller amounts were obtained. Hydrocyanic acid reacts quantitatively with silver nitrate to form a white precipitate of silver cyanide (12). After all of the gas had bubbled through the silver nitrate solution, the latter was titrated with a standardized solution of potassium sulphocyanate, ferric ammonium sulphate being used as an indicator. The amount of hydrocyanic acid present in the gas could then be calculated from the quantity of precipitated silver cyanide obtained.

In former experiments (13) the gas was caused to bubble through the silver nitrate solution by allowing kerosene to drip into the gallon bottle, thus displacing the gas and forcing it through the solution. The kerosene used had been thoroughly shaken with concentrated sulphuric acid until the latter no longer appeared yellow after standing in contact with the kerosene for five minutes. This was done to remove the unsaturated hydrocarbons, as it was believed that, in their absence, hydrocyanic acid would not be taken up by the kerosene. After a number of combustions had been made, two blank determinations were made with the kerosene by allowing it to displace air, instead of gas, from the gallon bottle. A negligible amount of silver cyanide was formed in the silver nitrate solution. After the kerosene had been used for some time longer, another blank determination was made. This time an appreciable amount of precipitate was obtained. It was, therefore, thought advisable to check the kerosene by using some other method of bubbling the gas through the silver nitrate solution. This was done by drawing a current of air through the gallon bottle with a suction pump. In another experiment, nitrogen was admitted into the gallon bottle containing the gas until atmospheric pressure was obtained. The contents of the bottle were then removed by suction. Much larger amounts of silver cyanide were obtained in

these experiments than in corresponding determinations in which kerosene was used. It was concluded that a large percentage of the hydrocyanic acid was taken up by the kerosene, and that the use of the latter would have to be abandoned. In all subsequent experiments the gas was drawn by evacuation from the gallon bottle through the silver nitrate solution. The pressure of the small amount of residual gas, which could not be removed by suction, was calculated from the manometric reading, and the amount of silver cyanide precipitate, which would have been formed from the entire volume of gas, could thus be calculated.

A qualitative test for the identification of a cyanide was made on the precipitates formed in the silver nitrate solution. The test used depends on the formation of a blood-red color due to ferric sulphocyanate. The test is performed as follows: a drop of yellow ammonium sulphide is added to a small amount of precipitate and evaporated to dryness. A drop of water is then added, followed by one of ferric chloride. In the presence of silver cyanide a blood-red color is obtained. The test was positive for all precipitates.

In the combustion of the nitrocellulose film in a vacuum, the following procedure was used: 12 gm. of film, cut into pieces about two inches square and made into a bundle, were placed in the two-liter, round-bottom flask, and the apparatus was evacuated. It was impossible to remove all of the air. A residual pressure varying from 10.5 to 16.5 mm. remained. The flask was then heated with a Bunsen burner until fumes appeared, after which the flame was removed, and the flameless combustion proceeded without external aid. After the apparatus had cooled to room temperature, the manometer was read and the stop-cock shutting off the gallon bottle from the rest of the apparatus was closed. The latter was again evacuated and a second combustion made

using 12 gm. of film, the stop-cock to the gallon bottle being opened when fumes appeared. The violence of the combustion forced small pieces of carbonaceous material through the outlet from the flask. It necessitated placing a 250 c.c. bottle for a safety trap between the flask and the manometer to prevent this material from clogging the stop-cock to the gallon bottle. The gas from these determinations was bubbled through three test tubes, each containing 10 c.c. of 0.1 normal silver nitrate solution.

In experiments on nitrocellulose film without gelatin, it was necessary to use much smaller quantities of film, as the combustions were more violent. Gelatin has a depressing influence on the combustion of nitrocellulose. When combustions were made in a vacuum, the residue consisted of a few black shreds. Three combustions of 2 gm. each were made in these determinations. The gas was drawn through two test tubes, each containing 10 c.c. of 0.05 normal silver nitrate solution.

Nitrocellulose film with gelatin in the amount of 8 gm. was used in the combustions at atmospheric pressure. In one experiment in which 12 gm. of film were used, pressure was developed sufficient to blow the rubber stopper out of the two-liter flask. To remove the hydrocyanic acid from the gas, 20 c.c. of 0.1 normal silver nitrate solution were used.

Experiments at atmospheric pressure could not be performed on nitrocellulose film without gelatin, because of the violence of the decomposition. In two experiments, 1 gm. of film was burned in a five-liter, round-bottom flask. In one case, the stopper of the flask was blown out, and, in the other, the outlet tubes from the five-liter flask and the 250 c.c. bottle were shattered. The film burned with a flame. The decomposition must have been complete, as there was no residue in the flask.

The procedure followed with acetate film

was practically the same in all cases. Film, 12 gm., was cut into pieces and loosely placed in the bottom of the flask. Heat was applied with the hot plate for 13 minutes in the combustions made in a vacuum, and 11 minutes in those made at atmospheric pressure. One three-minute heating period was followed by either four or five two-minute heating periods. The flask was allowed to cool for five minutes between the heating periods, otherwise, in the case of the combustions at atmospheric pressure, considerable pressure would have developed due to the gas being at a high temperature. In all of the experiments with acetate film, the gas was bubbled through two test tubes, each containing 10 c.c. of 0.05 normal silver nitrate solution.

When a combustion was made with the cellulose acetate film, a black precipitate formed in the silver nitrate solution. Two more determinations were made, in both of which brown precipitates were obtained. All of these precipitates gave a positive reaction for a cyanide with the ferric sulphocyanate test. As a white precipitate was obtained from a combustion of cellulose acetate film without the gelatin coating, it was thought that the black and brown precipitates might be caused by some reducing agent from the gelatin reducing the silver nitrate solution. Reducing substances in solutions containing hydrocyanic acid can be titrated with 0.1 normal potassium permanganate solution without loss of hydrocyanic acid (14). It was thought, therefore, that by placing a tube filled with potassium permanganate crystals between the gallon bottle and the tubes containing the silver nitrate solution, any reducing substances which might be present in the gas would be removed. This was done in all subsequent experiments with coated cellulose acetate film. The precipitates formed had only a light yellow tinge.

In all experiments, the apparatus was en-

closed with wire screening for protection. This was necessary even in the experiments with acetate film. In one determination at atmospheric pressure on cellulose acetate film, without the gelatin coating, the stopper of the two-liter flask was blown out and the fumes burned with flame in the flask. The ignition was probably caused by the hot gas, which undoubtedly had a high carbon monoxide content, coming into contact with the air.

The results of the experiments performed, given in the following tables, are calculated on the basis of 760 mm. pressure and 0° C. The percentages of hydrocyanic acid have been calculated on the actual volume of gas obtained. They do not include any air or nitrogen that was present before the combustion was made. All experiments were made on exposed film.

TABLE I.—EXPERIMENTS ON NITROCELLULOSE X-RAY FILM WITH THE GELATIN COATING, COMBUSTION TAKING PLACE IN A VACUUM

Residual Air Pressure	Grams Film Used	C.C. Gas per Gram Film	C.C. Gas in Gallon Bottle	C.C. HCN in Gas in Gallon Bottle	Percentage of HCN
(1) 13.2 mm.	24	244	2,839	44.8	1.58
(2) 12.5 mm.	24	238	2,732	45.6	1.67
Average		241			1.63

TABLE II.—EXPERIMENTS ON NITROCELLULOSE X-RAY FILM WITHOUT THE GELATIN COATING, COMBUSTION TAKING PLACE IN A VACUUM

Residual Air Pressure	Grams Film Used	C.C. Gas per Gram Film	C.C. Gas in Gallon Bottle	C.C. HCN in Gas in Gallon Bottle	Percentage of HCN
(3)* 16.4 mm.	6	264	624	6.2	0.99
(4) 14.7 mm.	6	272	645	5.6	0.86
Average		268			0.93

*Nitrogen was admitted into the gallon bottle containing the gas before the gas was bubbled through the silver nitrate solution.

TABLE III.—EXPERIMENTS ON NITROCELLULOSE X-RAY FILM WITH GELATIN COATING, COMBUSTION TAKING PLACE AT ATMOSPHERIC PRESSURE

Grams Film Used	C.C. Gas per Gram Film	C.C. Gas in Gallon Bottle	C.C. HCN in Gas in Gallon Bottle	Percentage of HCN
(5) 8	165	790	9.7	1.23
(6) 8	168	808	9.1	1.13
Average	166.5			1.18

TABLE IV.—EXPERIMENTS ON CELLULOSE ACETATE X-RAY FILM WITH GELATIN COATING, COMBUSTION TAKING PLACE IN A VACUUM

Grams of Film	Residual Air Pressure	C.C. Gas per Gram of Film	C.C. Gas in Gallon Bottle	C.C. HCN in Gas in Gallon Bottle	Percentage of HCN
(7) 12	10.5 mm.	55	396	3.6	0.9
(8) 12	11.5 mm.	57.6	415	3.4	0.82
Average		56.3			0.86

TABLE V.—EXPERIMENTS ON CELLULOSE ACETATE X-RAY FILM WITHOUT GELATIN COATING, COMBUSTION TAKING PLACE IN A VACUUM

Grams of Film	Residual Air Pressure	C.C. Gas per Gram of Film	C.C. Gas in Gallon Bottle	C.C. HCN in Gas in Gallon Bottle	Percentage of HCN
(9) 12	12.5	71	515	1.24	0.24
(10) 12	11.5	65.6	471	1.4	0.3
Average		68.3			0.27

TABLE VI.—EXPERIMENTS ON CELLULOSE ACETATE X-RAY FILM WITH GELATIN COATING, COMBUSTION TAKING PLACE AT ATMOSPHERIC PRESSURE

Grams of Film	C.C. Gas per Gram of Film	C.C. Gas in Gallon Bottle	C.C. HCN in Gas in Gallon Bottle	Percentage of HCN
(11) 12	44	318	1.28	0.4
(12) 12	49.4	355	1.14	0.32
Average	46.7			0.36

TABLE VII.—EXPERIMENTS ON CELLULOSE ACETATE X-RAY FILM WITHOUT GELATIN COATING, COMBUSTION TAKING PLACE AT ATMOSPHERIC PRESSURE

Grams of Film	C.C. Gas per Gram of Film	C.C. Gas in Gallon Bottle	C.C. HCN in Gas in Gallon Bottle	Percentage of HCN
(13) 12	51	370	0.45	0.12
(14) 12	57	409	0.41	0.1
Average	54			0.11

The difference between the results obtained in a vacuum and at atmospheric pressure was assumed to be due to the difference in the amount of oxygen present. However, it was thought advisable to determine whether or not the difference in pressure had any influence on the results. Experiments were, therefore, performed in an atmosphere of nitrogen. That is, the apparatus was evacuated and nitrogen, evolved by heating sodium nitrite and ammonium chloride, was admitted until the pressure it exerted was about half of an atmosphere. The results of these determinations are given in the following table:

TABLE VIII.—EXPERIMENTS ON NITROCELLULOSE X-RAY FILM WITH GELATIN COATING, COMBUSTION TAKING PLACE IN AN ATMOSPHERE OF NITROGEN

Grams of Film	Residual Air Pressure	Pressure of Nitrogen	C.C. Gas per Gram of Film	C.C. Gas in Gallon Bottle	C.C. HCN in Gas in Gallon Bottle	Percentage of HCN
(15) 12	13	325	245	1,766	23.7	1.34
(16) 12	14.7	347	234	1,688	27.2	1.61
(17) 12	13	349	243	1,753	26.9	1.53
Average			241			1.49

The results of Experiments No. 16 and No. 17, given in Table VIII, are in very close agreement with those obtained on nitrocellulose film with gelatin coating when

the combustion was made in a vacuum. Even when the results of Experiment No. 15 are included, the average of the three determinations shows that any influence which the pressure may have on the amount of hydrocyanic acid formed is very small. It is believed that evacuation is a satisfactory method for limiting the amount of air for combustion.

SUMMARY

1. As 0.3 per cent is rapidly fatal, toxic concentrations of hydrocyanic acid were obtained in all of the experiments performed, except those on cellulose acetate film without the gelatin coating.

2. The results of the determinations made in a vacuum (and of those in an atmosphere of nitrogen) are very appreciably higher than those in which the air supply was limited to the amount of air enclosed in the apparatus. It can, therefore, be concluded that the amount of hydrocyanic acid formed decreases as the amount of available air increases, and that, if the films were burned in an excess of air, hydrocyanic acid would probably be absent entirely. This point has been established by other investigators (5), who state that hydrocyanic acid is not present in the gas from either nitrocellulose or cellulose acetate films when they are burned in an excess of air.

3. Hydrocyanic acid is apparently formed both from the gelatin coating and from the base of the film. The ratio of the amount of hydrocyanic acid formed from the gelatin to that formed from the film base is greater in acetate films than in nitrate films. These results would be expected from a theoretic consideration of the composition of the bases of the nitrate and acetate films. The nitrate base obviously contains a large amount of nitrogen, whereas the acetate base presumably does not contain any, and it would be expected that hydrocyanic acid would not be formed from the latter. Ex-

periments were not done to determine the source of the nitrogen which was necessary to form the hydrocyanic acid from the cellulose acetate base. Olsen, Brunjes, and Sabetta (5), however, found 0.34 per cent of nitrogen in an acetate film without the gelatin coating.

4. Although a large percentage of the hydrocyanic acid comes from the coating of both the nitrocellulose and cellulose acetate films, the gelatin probably reduces the fire hazard, as it appears to have a depressing influence on film combustion. There was a larger amount of residue from both types of film when the combustions were made on films with the gelatin coating. The amount of gas obtained, however, was larger when the combustions were made without the coating. The depressing influence of the gelatin appeared to be greater in nitrate film than in acetate. A considerable amount of carbonaceous residue and a small amount of condensate were obtained from the nitrate film with the gelatin coating. The removal of the gelatin resulted in a more complete type of combustion, as the residue consisted of only a few black shreds. Moreover, the nitrate film without gelatin burned with a flame when decomposed at atmospheric pressure. A flameless type of combustion was always obtained from films with the gelatin coating.

5. In order to decompose cellulose acetate film, it was necessary to keep it at a high temperature. Despite the high temperature, a very incomplete type of combustion resulted. The volume of gas obtained was small compared to that from the nitrate film, and a large amount of residue remained. While the films were being heated, they appeared to melt, forming a boiling liquid, which solidified into a very hard residue when the heat was removed. The acetate film without gelatin appeared to liquefy more completely when hot than the acetate film with the gelatin coating. A larger

amount of gas and a smaller amount of residue were obtained from the former.

6. Although fatal concentrations of hydrocyanic acid were obtained in these experiments, it does not necessarily follow that hydrocyanic acid would be liberated in toxic quantities from much larger amounts of film. It is impossible to duplicate in a laboratory the conditions which exist when thousands of pounds of film decompose. However, it is reasonable to suppose that the air supply would be limited, and, in that case, that hydrocyanic acid would be formed. Under such conditions, carbon monoxide and the oxides of nitrogen would also be liberated from nitrocellulose films and carbon monoxide from cellulose acetate films. The danger of poisoning from hydrocyanic acid would be less than from either carbon monoxide or the oxides of nitrogen, as hydrocyanic acid is evolved in much smaller amounts. Fatal concentrations of carbon monoxide and of the oxides of nitrogen would still be present if concentrated fumes were diluted with a quantity of air sufficient to decrease the amount of hydrocyanic acid to non-toxic concentrations. Hydrocyanic acid, however, undoubtedly contributes to the toxicity of the gases evolved when large amounts of X-ray films decompose.

A consideration of the results obtained in this investigation leads to the conclusion that cellulose acetate films are superior to nitrocellulose films, from a safety standpoint, for three reasons:

1. Cellulose acetate films are more stable than nitrocellulose films. The latter readily decompose at 150° C., while acetate films must be kept at a high temperature in order to obtain decomposition.

2. Much larger amounts of gases are evolved from the flameless combustion of nitrocellulose films than from cellulose acetate films. Decomposition of the former is much more complete in a limited air supply,

as nitrate films contain a large amount of oxygen compared to acetate films.

3. Hydrocyanic acid is liberated in smaller quantities from acetate films than from nitrocellulose films. The oxides of nitrogen are entirely absent from the gases liberated from acetate film. Carbon monoxide, as shown by other investigators, is the only toxic gas liberated in comparable quantities from both types of film.

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DISCUSSION

PAUL C. SEEL (Rochester, N. Y.): After reviewing Miss Ballard's paper, we feel that she is deserving of no little credit for the manner in which she has conducted her investigation and assembled data from various sources. There are several points, however, which perhaps should be commented upon, these being as follows:

Miss Ballard states: "Celluloid burns only when brought in contact with a flame." It is possible under certain conditions, if nitrocellu-

lose products, such as celluloid sheets or nitrocellulose films, come in contact with heat, to start decomposition, the products of which act as a catalyst, increasing the rate of decomposition, which raises the temperature sufficiently to cause ignition.

Further, Miss Ballard states: "Cellulose acetate or safety films did not decompose under the conditions under which nitrocellulose film did." Whereas the term "decomposition" can be correctly used with reference to any chemical breakdown such as is produced by heat, we feel the use of this term in describing the disintegration of cellulose acetate film by heating is to be discouraged. Persons familiar with the breakdown of nitrocellulose products have come to use the term "decomposition" in describing the reaction which is exothermic after the material has once been brought to a sufficient temperature for only a short period of time. Cellulose acetate films, on the other hand, require a continuous application of heat at an elevated temperature in order to accomplish this breakdown.

Later on, she says that some samples of nitrate film decomposed after from 30 to 40 seconds of exposure to a source of temperature of 250° C. (namely, a bath of molten paraffin into which was plunged a test bath containing the sample of film tied on to a thermometer bulb) although the temperature of the thermometer was raised to only 65° or 70° centigrade. Miss Ballard made some determination purporting to show that these low readings were not due to lag of the mercury in the thermometer bulb. It may be pointed out, however, that, under the conditions, she was not reading the equilibrium values and that the temperature readings have little meaning if they are not equilibrium values. The film was actually exposed to a source of heat at a temperature of 250° centigrade. Not only radiation of this temperature was reaching the film, but also any gas molecules having kinetic energy much higher than the average recorded by the thermometer. In our experience the temperature to which the film is raised by an exposure to a source of radiant heat can be ascertained only by careful calorimetric experiments.

Miss Ballard describes the method which she has used for determining the hydrocyanic formed. The Eastman Kodak Company's Re-

1929, in the Research Laboratories of the Eastman Kodak Company, are quite comparable with those obtained by Miss Ballard ex-

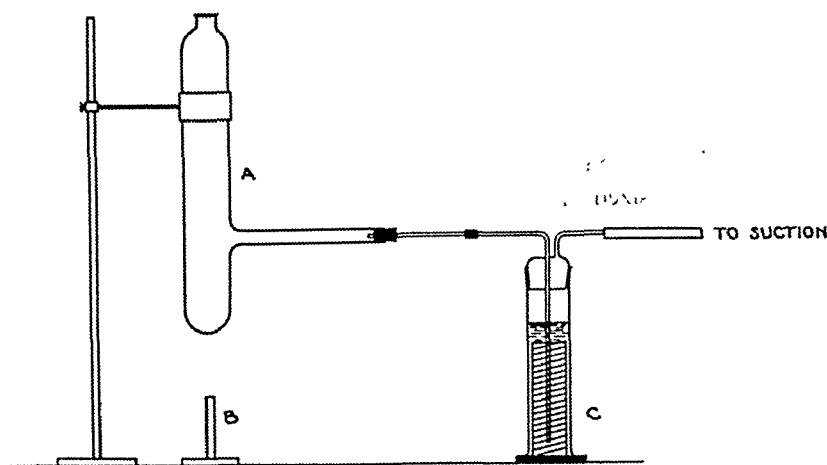


Fig. 1. The film was burned in the combustion chamber *A*, which is heated by the Bunsen burner *B*. The gaseous decomposition products were drawn off by suction, and passed through the Fisher gas washing bottle *C*, which contained a 10 per cent solution of sodium hydroxide. The downward draft produced by the suction prevents any of the gases from escaping at the top of the combustion chamber. The bottom part of the chamber, below the side-arm, becomes filled with the gaseous decomposition products, and the film is, therefore, decomposed in insufficient air to afford complete combustion.

The procedure for the quantitative estimation of the amount of hydrogen cyanide formed was based on the method published by Dundell and Bridgeman (*Jour. Ind. Eng. Chem.*, 1914, VI, 554). Other methods, such as those of Lubig and Volhard, were tried, but they were found to be unsatisfactory for various reasons. The method adopted depends upon the titration of the cyanide ion with nickel ammonium sulphate, using dimethylglyoxime as indicator. The nickel sulphate solution forms a soluble sodium nickel cyanide complex which removes the nickel ion from solution until an excess has been added. The presence of the excess is shown by the appearance of the pink color of nickel dimethylglyoxime, indicating the endpoint of the titration. The method, which was tested with known amounts of a standard potassium cyanide solution under the same conditions used in our experiments, was found to give trustworthy results.

For the experiments on the quantitative estimation of hydrogen cyanide, the following procedure was used. The sample to be tested was decomposed and the fumes absorbed, as previously described. The alkaline solution was acidified and distilled in a similar way, except that the distillate was absorbed in a dilute solution of ammonium hydroxide. The ammoniacal distillate was then titrated with a standard nickel ammonium sulphate solution as described above.

search Laboratory feels that the method which Miss Ballard used is not quite so accurate as the one which they employed (Fig. 1).

She gives the results of tests showing the amount of hydrocyanic acid gas liberated by the heating of cellulose acetate and nitrate films and film supports. Results of similar determinations made on or about August 14,

cept in the case of the safety X-ray film support from which the emulsion layers have been removed. In this case our laboratories found no hydrocyanic acid to have been liberated whereas Miss Ballard shows 0.11 per cent. We are inclined to the belief that the difference in the results obtained by the two laboratories is due to the fact that it is very difficult to remove entirely the emulsion from

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by well-known and authoritative workers have shown that the acetate film is the safest to use. Therefore, I think it is incumbent upon the radiologists of this country to use a product which guarantees a certain amount of safety to the public, in whose welfare we are interested.

I want to say in conclusion that, when a medical man tries to say a word or two commending a commercial product, he is immediately accused of having an ulterior motive. We have had that experience in Milwaukee, where we have tried to enforce a regulation making every radiologist use the acetate film. Despite this, I am going to be bold enough to say I do not care what you think or what thoughts you carry away, but I am convinced that we ought to use acetate film.

MISS BALLARD (closing): The objections made by Mr. Seel to the experiments in which the nitrate film decomposed at 65-70° C. do not seem reasonable. The large glass tube, as well as the thermometer which was suspended in it, was at room temperature before it was plunged into the hot paraffin bath. As the small piece of film was fastened directly on the thermometer bulb, it received the same amount of heat as the thermometer. Although the heat was radiated from a hot paraffin bath at 250° C., the thermometer would still record the temperature of the air in the tube. Thermometers are used to record fluctuating as well as constant temperatures. The argument that some gas molecules have kinetic energy higher than the average recorded by the thermometer does not necessitate discarding the results of these experiments. The same argument would apply to the experiments in which

the film decomposed at 150° C., and, in general, to any case in which a thermometer is used to record the temperature of a gas. The determination of the amount of heat present by means of a calorimeter, as Mr. Seel suggests, would not be superior to measuring the temperature of the air with a thermometer, because a calorimetric determination would also measure the average kinetic energy of the air molecules. It is believed that the decomposition temperature of from 65 to 70° C., obtained when a small piece of film was suddenly subjected to a great amount of heat, is approximately correct.

Mr. Seel believes that the difficulty of completely removing the gelatin coating was responsible for the hydrocyanic acid obtained from cellulose acetate film without gelatin. Although traces of gelatin probably remained on the film, the very small amount which was left could hardly be responsible for all of the hydrocyanic acid formed. The amount obtained from acetate film without gelatin is 30 per cent of the amount given off by the coated film. Only 70 per cent of the gelatin was removed, if the latter was the only source of hydrocyanic acid. The amount of gelatin left on the film was very much less than 30 per cent of the total amount of gelatin originally present.

Mr. Seel states that the hydrocyanic acid formed from large amounts of safety film would probably be diluted with other gases from the film. This dilution, however, is included in the concentrations of hydrocyanic acid found, as the percentage of hydrocyanic acid was calculated from the entire amount of gas obtained.

THE ANNUAL MEETING

In spite of the financial depression and the long distance many of our members had to travel to reach the Atlantic City meeting, the Eighteenth Annual Meeting was a great success. Several hundred members represented all parts of the United States and Canada; in fact, the registration surpassed in number the fondest expectation of the officers of the Society.

The technical exhibitors were well represented and, as usual, showed the latest achievements in American manufacture of X-ray and radium apparatus. All of their exhibits were not only interesting but instructive, as evidenced by the large attendance by the members of the Society.

The scientific program was of a high order, and the efficient manner in which the Presi-

(Continued on Page 46)

the film base due to the intimate bond between the base and the light-sensitive layers.

In the following table are shown the amounts of hydrocyanic acid gas which Miss Ballard found in the two types of film and the supports obtained from same by removing the emulsion compared to results obtained by the Eastman Kodak Research Laboratories on similar materials. There are also shown the amounts of hydrocyanic acid gas formed by heating wool yarn, glue-sized paper, and leather under conditions similar to those employed in heating the samples of film and film base:

	Miss Ballard's results Per cent	Eastman results Per cent
Nitrate X-ray film support....	0.93*	0.93
Nitrate X-ray film.....	1.18	1.43
Safety X-ray film support....	0.11	0.00
Safety X-ray film.....	0.36	0.50
Wool yarn	—	5.00
Glue-sized paper	—	0.66
Leather	—	3.00

*This result obtained by running test in vacuum.

When wool yarn, which is so commonly used for making rugs, carpeting, and draperies, is heated under destructive distillation conditions, it gives off approximately ten times the amount of hydrocyanic acid gas as is liberated from a like amount of safety X-ray film, and somewhat over three times the amount of hydrocyanic acid gas that is given off from nitrate X-ray films. A much higher percentage of hydrocyanic acid is given off from leather, or even from certain types of glue-sized papers, than from films. Of course, there is no question in anyone's mind as to any hazard existing from the slow burning of any one of these three materials.

The results as stated in Miss Ballard's paper agree in the main with the large amount of data which are available and are well known to persons who use the two types of X-ray film. There is only one other question which should be raised in connection with Miss Ballard's results: that is, while there may be sufficient quantities of hydrocyanic acid gas liberated from the destructive distillation of safety X-ray film to produce lethal dosages when the decomposition gases are not diluted with air, it is highly improbable that such results would

be obtained when large quantities of X-ray films were slowly burned, for the hydrocyanic acid gas formed would undoubtedly be diluted either with other gases liberated from the film or with the surrounding air so that the amounts present would be considerably below the lethal amounts as described, *viz.*, 0.3 per cent.

In conclusion we want to state that one of the most important differences between nitrate and safety X-ray films is the fact that, if the nitrate film is heated and decomposition started, the reaction continues until the film is entirely consumed. With safety film, the breakdown can be effected only by continuously applying an external source of heat at a relatively high temperature, and if the source of heat is withdrawn, no further breakdown occurs.

DR. H. B. PODLASKY (Milwaukee, Wis.): Practically speaking, we have heard a great many comments on whether, in our everyday work, we should use safety film or nitrocellulose film. I care very little for absolute figures in medicine because you have seen how different laboratories, different physicists, will put the period at different places and the zeros in different places. What you want to do, perhaps, is to draw general conclusions.

The experiments of Eastman, with their wonderful facilities, absolutely show, I think, that Miss Ballard's work in the main is corroborated. The problem as to whether hydrocyanic acid, when liberated from the destruction of X-ray films, is actually the only cause of death, either immediate or remote, is not quite so important as the probability that hydrocyanic acid has been found under conditions which we know least about and which are enigmatic. Miss Ballard has shown that under certain conditions it is possible to get hydrocyanic acid; that it is a hazard which is to be considered in other fire occurrences I do not think is quite the consideration because we are not wool workers, we are not carpet workers, and we do not care very much about the presence of hydrocyanic acid except as it applies in our work with X-ray films.

One could carry this discussion on, I think, *ad libitum* and *ad nauseum* but it does remind one of this: the experimental data amassed

same average wave length with the same given filter thickness.

Inasmuch as the absorption curve appears to be the fundamental basis upon which modern methods of measuring radiation quality are established, it would appear desirable to investigate the physical meaning of the nature and character of absorption curves. Experimentally, it has been found that, in some instances, the semilogarithmic absorption curve becomes a straight line, and in other instances it remains curved. While making a large number of absorption curves under the most highly varied conditions, certain regularities have appeared, which are discussed and investigated.

THEORY

X-ray Spectrum.—When measuring the intensity of the different wave lengths of a radiation beam and plotting the wave lengths as abscissæ with the corresponding intensities as ordinates, we obtain a curve of an intensity wave length spectrum. A corresponding frequency spectrum, or an absorption coefficient spectrum is obtained if the proper transformations are made. The three spectra differ markedly in form and shape, but the areas under each of the three curves are equal and each area represents the total energy of the radiation (5). It can, therefore, be assumed that the area of any wave length band can be taken as a measure of the intensity of that band, compared with the intensity of another band of a different wave length in the same spectrum. Of course, if these wave length bands are located far apart on the wave length scale, then such a comparison could not be made, except after adequately correcting for the various factors that cause a deviation of the measured spectrum from the true spectrum. However, if the two areas are located close together and far to the short wave length end, then the meas-

ured ratio can be assumed to be reasonably close to that existing in the true spectrum.

If the radiation is filtered, for instance with regularly increasing filter thicknesses, as is done when an absorption curve is

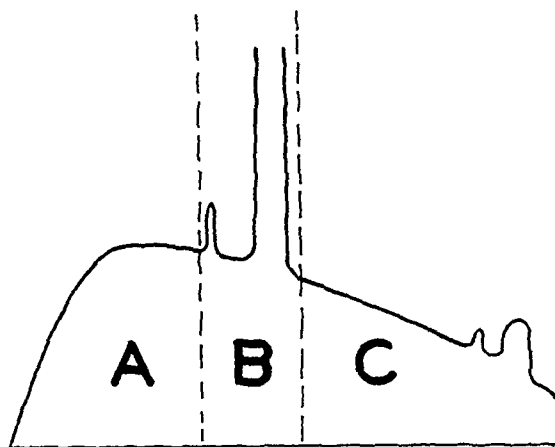


Fig. 1. A convenient way of dividing an X-ray spectrum into three zones.

made, then the two bands decrease in intensity, each in accord with its absorption coefficient. Hence, the intensities of the two bands represent two points of an absorption curve.

Therefore, in a spectrum of a radiation above the characteristic voltage of the anode metal, three wave length zones can be outlined, each of which appears characteristic in different absorption curves. The band from the minimum wave length to the beta first order *K* line shall be designated as area *A* (Fig. 1); the band from the beta to and including the alpha *K* lines shall be designated as area *B*, and the remaining longer wave length portion of the spectrum as area *C*.

Absorption Curve.—Quite a different kind of curve is obtained if the intensity of the X-ray beam is measured each time after an additional thickness of metal has been placed in the beam. If these measured results are plotted as ordinates on a logarithmic scale

ABSORPTION CURVES AND SPECTRA OF X-RAY BEAMS¹

By A. MUTSCHELLER, PH.D., NEW YORK

DURING the Second International Congress of Radiology, in 1928, the committee elected to use, as a measure for radiation quality, an absorption curve in a known metal. However, during the Third International Congress, in 1931, the committee elected to rely upon the half value filter thickness as a measure for the radiation quality. While the first step was certainly commendable, the second is not of a character that indicates, from the theoretical point of view, that it has been made with good judgment.

The striking contradiction brought out in these decisions makes clear that either there is a lack of information of the exact meaning of the characteristics of an absorption curve, or that some of the properties of the radiation, as represented by the absorption curve, are generally overlooked. In some instances, the theoretical requirements for absorption curves seem to be fulfilled, but in others there seems to be disagreement with the theory as it is now formulated. This variance demands a more definite and rigorous interpretation of the characteristics of absorption curves.

Moreover, there are several frequently used tests for measuring and defining radiation quality which, fundamentally, are only different ways of interpreting absorption curves. If spectral measurements are excluded because they are too complicated for practical clinical purposes, then there is but the absorption curve that can be used for a dependable definition of radiation quality. From it, three distinct measures can be derived to define the quality of the radiation, really three different methods of interpreting the absorption curve.

1. The half value layer method, which is represented by the point on the absorption curve corresponding to a radiation decrease to one-half its original intensity.

Mathematically, it is equal to determining the slope of a secant of the absorption curve. It is obvious that this measure usually does not represent the actual composition of the beam as it passes through the filter.

2. The effective wave length, which is obtained from measuring the intensity before and after a known filter is introduced.

This measure also represents the slope of a secant, quite similar to that obtained with the half value layer method. Perhaps the results are a little more reliable, if the effective wave length measurement is made with the actual working filter used and the measuring filter is added to it, but the value obtained still depends upon the metallic measuring filter. Of course, a different value is obtained for this effective wave length for each and every metal used as a measuring filter.

3. The average wave length, which is a measure of a tangent to the absorption curve at the point which represents the thickness of the working filter.

As the author has pointed out (1, 2, 3, 4), this method is fundamentally the only dependable one for the correct definition of radiation quality. The measure of the average wave length is independent of the metal employed and only radiations which have absolutely identical spectra can possibly give the

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

When the filter thickness is increased, the curve gradually becomes more and more straightened out at the rate at which the radiation on the long wave length side of the characteristic lines has been filtered off. In some instances, it is found that the curve becomes an absolutely straight line; in other instances, it remains slightly bent. This seems to depend on the type of current or on the type of generating apparatus used for the production of the high voltage current and will be further discussed later on.

Until recently, the principal value of the absorption curve lay in the information that could be derived from it with regard to the effects of filters. Thus it was assumed that, if the absorption curve were straight, then nothing could be gained by increasing the filter thickness. Recently, however, some doubt has been expressed, based on the clinical evidence that a still different effect could be obtained with heavier filters.

Then, of course, there is the slope of the absorption curve which has always been considered as indicating the penetrating qualities of that radiation (5). With the aid of several known and experimentally proven relations, it was feasible to derive equations giving the radiation qualities in terms of half value layer thickness, effective wave length, and average wave length (5).

Due to the great importance of the absorption curve in measuring the quality of white X-ray beams, it is necessary to make a careful comparison between the meaning of the various indices of the spectrum and the absorption curve.

EXPERIMENTS

The experimental work has for its purpose the demonstration of the differences between the spectrum obtained with an X-ray tube energized with pulsating current, for instance, from a mechanical rectifier, and that obtained from an X-ray tube energized with uniform or constant voltage cur-

rent. These spectra are to be compared with absorption curves and, if possible, the differences in the characteristics of the absorption curves above referred to are to be accounted for.

Apparatus "A" is a uniform voltage condenser type apparatus, with capacities of at least 0.1 M.F. The X-ray tube was operated with 2 ma., and 200 minimum wave length kilovolts. Apparatus "B," a mechanical rectifier, was operated, using the same tube with 3 ma. and 200 K.V. measured with a sphere gap.

The X-ray tube has a specially fine focal spot of 5 mm. diameter. It is housed in a lead-lined drum provided with an opening through which the rays are directed through a similar opening in a wall upon the spectrograph located in another room. The diaphragms are of progressive sizes, approaching the spectrograph so that only direct rays coming from the active focal spot reach the NaCl crystal.

The spectrograph is of the rocking crystal type, especially constructed to insure absolute protection of the photographic films against stray rays. The filters were placed in the beam before it reached the spectrograph and the exposure times were so calculated, taking intensity data from the absorption curve, that all spectrograms received the same radiation dose. The spectra were all developed in one solution for the same length of time and they were then measured separately by a photometer. The direct results are plotted in Figures 2 and 3 (8). The lower scale is in millimeters along the film, each millimeter being equal to 0.0133 Ångström unit. The vertical scale, giving intensities, is in arbitrary units.

The absorption curves were then made with an instrument measuring only primary radiation. After the longer time has been divided by the shorter, the absorption data express, in percentages of the full unfiltered radiation, the intensities passing through

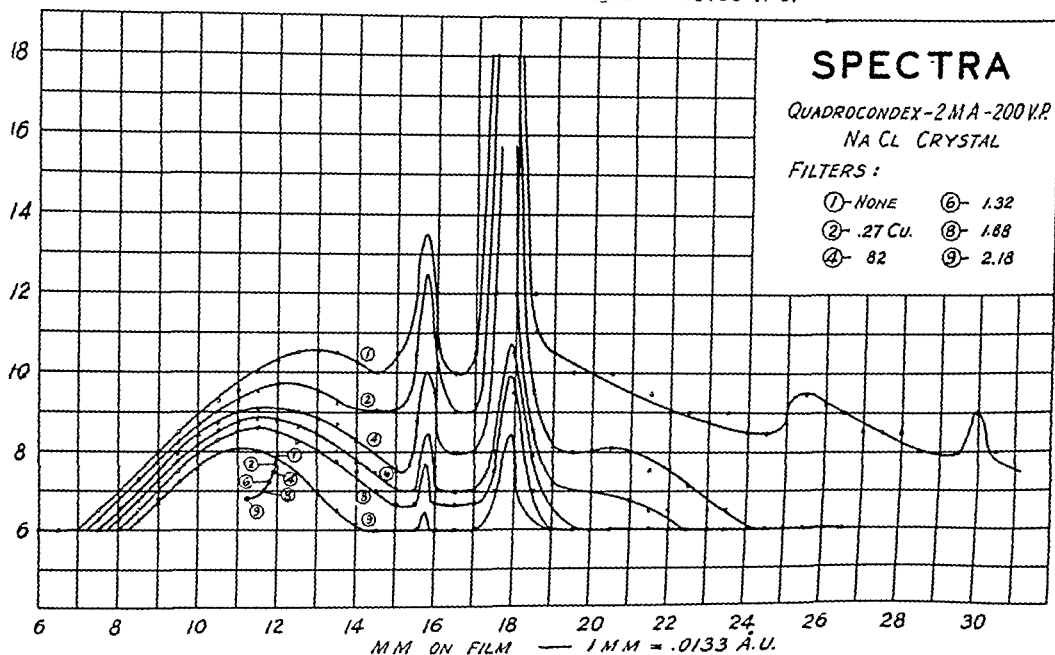
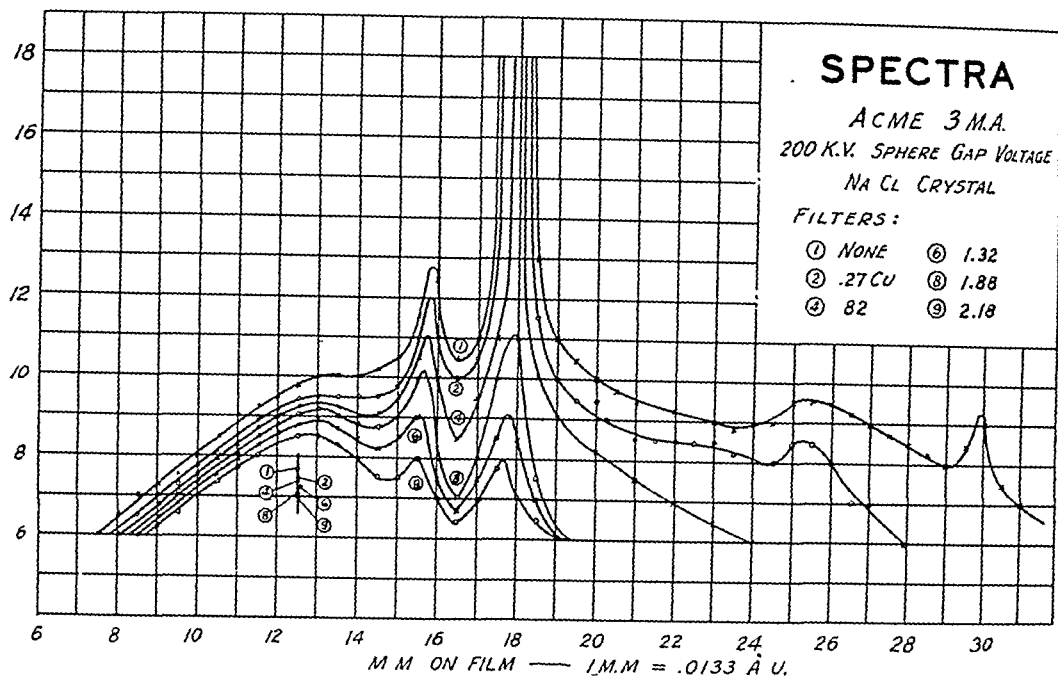


Fig. 2 (above). X-ray spectra of Wo radiation with 200 K.V. of a mechanical rectifier through various filter thicknesses.

Fig. 3 (below). X-ray spectra of Wo radiation with 200 K.V. uniform voltage through various filter thicknesses.

and the thickness of the metal as linear abscissæ, then we obtain a semilogarithmic absorption curve.

When the filters are thin, the curve, which is usually concave upward quite strongly at the start, gradually decreases in curvature.

form voltage current. The reason for this may lie in the fact that the characteristic lines which are excited above 70 K.V., in a transient voltage curve, are excited for a much longer time than, for instance, the

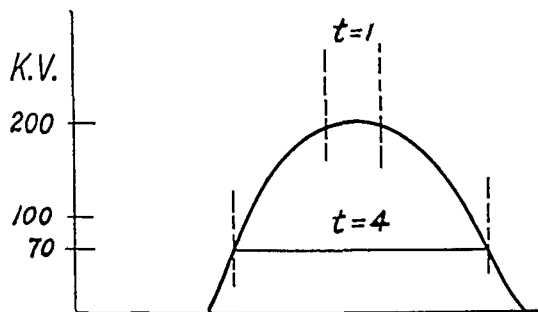


Fig. 6. A sine wave curve showing the relative exposure time for the characteristic K lines and the short wave length portion of the W_o spectrum.

short wave length end, which is excited only during the short time when maximum peak voltage exists (Fig. 6). This means that usually the characteristic lines are exposed four or five times as long as those of the short wave length part, and hence a proportional over-exposure of the characteristic lines is to be expected over the short wave length end of the spectrum. Of course, in the uniform voltage spectrum, all parts are exposed for equal lengths of time and all parts of the spectrum are probably more uniformly and more truthfully reproduced as the spectrum of tungsten. However, it is quite certain that, even in this case, there is considerable exaggeration of the actual width of the spectral lines, due to over-radiation.

The long wave length portion of the spectra in the two cases does not seem to offer anything of great importance except that in both cases approximately 0.75 mm. Cu is necessary as a filter for complete stoppage.

Of principal practical importance is the fact that, because it produces much greater radiation energies in the characteristic line

zone, than does the X-ray tube energized with uniform potential, the pulsating current produces proportionally smaller amounts of radiation energy on the short wave length portion of the spectrum.

The spectra were then divided into three vertical areas, as previously outlined, the dividing lines being at the 15- and the 19-mm. vertical lines (Figs. 2 and 3). The geometric center of gravity of each of these areas was then determined. The spots marked 1, 2, 4, 6, 8, and 9 are the respective centers of gravity of the areas under each of the like marked curves. It is characteristic that in the spectrum of pulsating current, the centers of gravity of the short wave length areas are perpendicularly superposed. In the spectra obtained with uniform voltage, the centers of gravity of the heavier filtered short wave length areas are shifted distinctly toward the short wave length end. In the pulsating current, however, filtering does not appreciably change the wave length of the short wave length area; therefore, the average wave length of the radiation should remain unchanged by filtration. In uniform voltage rays, the average wave length changes, becoming shorter with every added filter thickness.

It is quite obvious that the center of gravity of the characteristic lines remains unchanged and, therefore, we can draw the conclusion that, with pulsating voltage, the average value of the wave lengths, *i.e.*, of the characteristic portion and of the short wave length portion, remains constant when the thickness of the filter is increased. With uniform voltage, however, the average value of these two wave lengths changes toward the short wave length end as the filter thickness is increased. This condition is then related to the fact that the absorption curve (Fig. 4) obtained with pulsating current shows straight line characteristics from a filter of 1 mm. of copper on. The absorption curve made with uniform

each of the filter thicknesses. The data obtained are directly plotted in Figures 4 and 5 on semilogarithmic cross-section paper. The horizontal line gives the absorber thicknesses in millimeters of copper; the vertical

shaped and have a distinct intensity maximum, separate and away from the characteristic lines. Those obtained with pulsating current, however, are of a more gradually ascending shape and do not have a maxi-

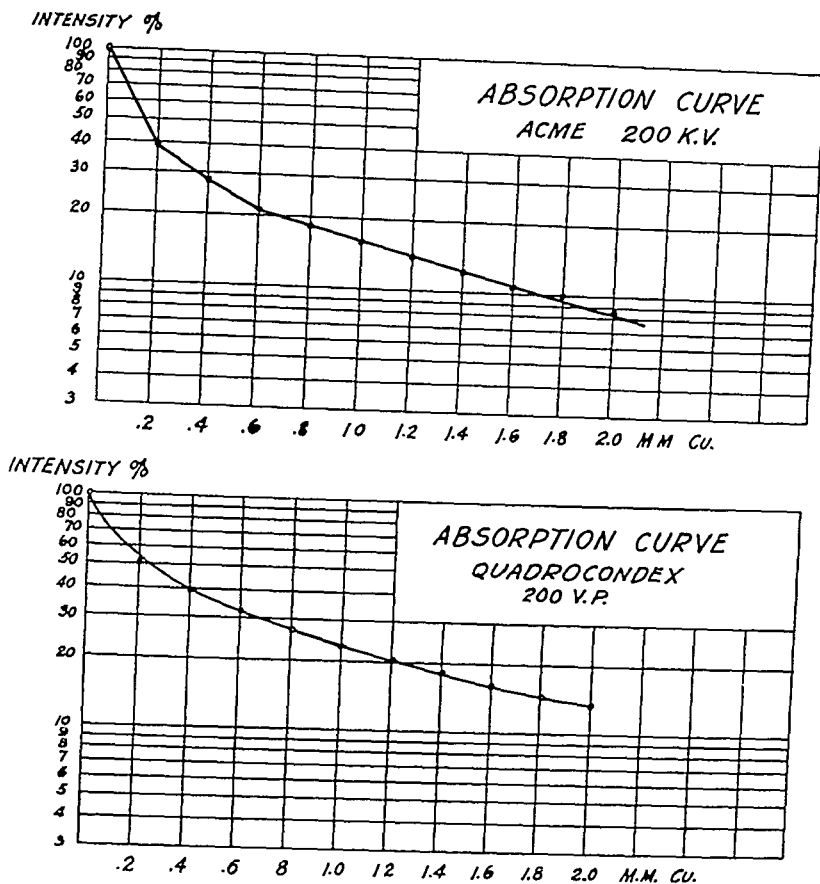


Fig. 4 (above). Semilogarithmic absorption curve of Wo radiation with 200 K.V. of a mechanical rectifier.

Fig. 5 (below) Semilogarithmic absorption curve of Wo radiation with 200 K.V. uniform voltage.

logarithmic line gives the intensity percentages in terms of the non-filtered radiation.

Characteristic in these spectra is the fact, previously reported, that the intensity maximum on the short wave length side of the characteristic lines is quite differently located on the wave length scale in the two groups of curves. The curves obtained with uniform voltage current are dome-

shaped and have a distinct intensity maximum which is distinctly separate from the characteristic lines. Rather, they gradually fuse with the beta line of tungsten. Only the heavier filters gradually effect a separation of the short wave length area with an intensity maximum away from the beta line.

The characteristic lines produced with pulsating current are distinctly wider and heavier than those obtained with the uni-

Consequently, we have to differentiate, before any discussion can go further, between four distinct methods of wave length measurement. These methods are illustrated with an absorption curve, for all really con-

ous filters in accord with the fact that each filter changes the composition of the radiation in its own characteristic way. Hence the average wave length is the only measure that is characteristic of the radiation and

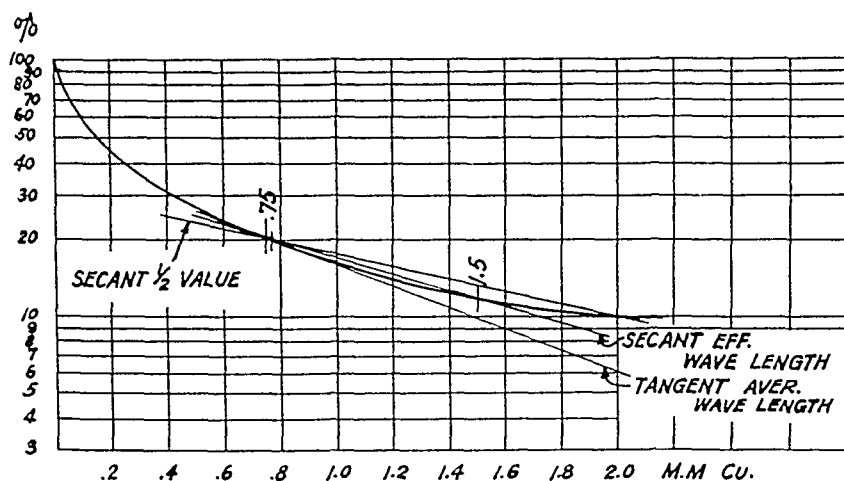


Fig. 7. Mathematical representation of the half value layer effective wave length, and average wave length as a description of radiation quality.

sist of special cases of interpreting absorption measurements. In Figure 7

1. The half value layer method is represented by "secant one-half value."
2. The effective wave length, or fixed filter method, is represented, for a filter of 0.75 mm. Cu, by "secant effective wave length."
3. The average wave length, when the absorption curve is not a straight line, is represented, for a filter of 0.75 mm. Cu, by "tangent average wave length."
4. The average wave length, when the absorption curve is a straight line, is represented by the same line as the "tangent average wave length."

There are, therefore, four distinct concepts, three of them giving different numerical values, as Schwarzschild has pointed out. Only the average wave length gives but one value which is not dependent upon the absorption material used to measure the radiation. Its value, of course, differs for vari-

ous filters in accord with the fact that each filter changes the composition of the radiation in its own characteristic way.

Regarding the interpretation or utilization of the absorption curve, it has been pointed out by the writer that neither the ratio

$\frac{I_0}{I_x}$ nor $\log \frac{I_0}{I_x}$ has an interpretative or descriptive value, nor has it either any simple relation to biologic or energetic effects (3).

The following equations were derived for its interpretation:

$$\log \frac{I_0}{I_x} = 74.8\lambda^3 + 0.05 \text{ for 1 mm. Cu}$$

$$\log \frac{I_0}{I_x} = 9.1\lambda^3 + 0.085 \text{ for 5 mm. Al}$$

giving average wave length

$$\log \frac{I_0}{I_x} = \frac{74.8 \times (3 \times 10^{18})^3}{\nu^3} + 0.05$$

for 1 mm. Cu

$$\log \frac{I_0}{I_x} = \frac{9.1 (3 \times 10^{18})^3}{\nu^3} + 0.085 \text{ for 5 mm. Al, giving average frequency.}$$

voltage radiation (Fig. 5), however, shows a uniform slight bend, especially in the part corresponding to the thicker copper filters.²

METHODS

The term "average wave length" was proposed by the writer in 1924 (1). At that time, the experimental work was performed with mechanical rectifiers which were always found to give straight line semilogarithmic absorption curves. The meaning of the term "average wave length" was, therefore, studied only along the straight line part of the absorption curve and it was then defined as "the wave length of a homogeneous radiation that is equivalent and absorbed to the same degree as the radiation tested" (1). A mathematical definition was also given, and, translated, it is: "The average wave length of a radiation is the wave length of an equivalent homogeneous radiation whose absorption is equal to that of the radiation tested" (2). It should, therefore, be quite clear in cases in which the absorption curve and the tangent to it are falling together, that it was proven experimentally in 1924 that the depth doses are proportional to the average wave length and, hence, that this term is a complete description of the radiation quality.

Later, however, when further studies were made, the method of measuring the average wave length was extended and it was stated, "Not only that part of the curve which is shown as a straight line and in which the absorption coefficient is constant can be used, but also any other point along the plot, even where it is curved, can be taken to determine the average wave length"

(4). The average wave length is, therefore, to be determined from the slope of a tangent to the absorption curve drawn at the point corresponding to the filter.

In discussing average and effective wave lengths, in a recent paper (6), Taylor concludes that absorption curves are always curved and that "the most logical expression of the 'effective wave length' is obtained when using the absorption coefficient given by the slope of the logarithmic absorption curve. This is called the true effective wave length." What Taylor calls "true effective wave length" is just the average wave length, for both are determined by exactly the same process.

Wilsey (7) discusses the fixed filter, or effective wave length method, using Taylor's curves, and shows the inherent weaknesses of the method. However, he then comes to the conclusion that the absorption curve, which he defines as a curve giving $\log I$ or

$\log \frac{I}{I_0}$ plotted against the filter thickness,

has all the virtues which are to be expected of a satisfactory method of defining the quality; but the method which he refers to for determining it is also identical in every detail with the average wave length method, except that he proposes to record his measurements as the logarithm of the intensity ratio instead of calculating from this ratio the average wave length.

This leads us to the conclusion that the "average wave length" is an adequate measure of radiation quality even when the absorption curve is not a straight line, but no experimental proof of any kind is furnished.

A distinct contribution was made by Schwarzschild (5), who gives four distinct definitions of average wave length, all of which apply to the experimental results obtained from the slope of the absorption curve for varying thicknesses of absorbing material.

²Despite the fact that the spectrograph received through each one of the filters the same total radiation dose, the areas under the spectra are considerably smaller with heavier filters than with the thinner ones or the non filtered radiation. This is probably due to the dependence of the photographic effects upon wave length and the necessary crystal correction. Both these sources of error have not been accounted for in this work because we are here comparing spectra with approximately the same wave length distribution in the respective bands

slope of a tangent to an absorption curve are only conditionally justified, *i.e.*, in that case alone when the absorption curve is a straight line.

From this it follows that the bent absorption curve cannot be interpreted, with respect to radiation quality or depth doses, except by further treatment either mathematically, to account for the deviation of the absorption curve from the straight tangent, or by special filters, perhaps combinations of several metals through which straight line semilogarithmic absorption curves are obtained.

Then, in that case, the slope of a tangent, or the average wave length, has a definite meaning in that it definitely describes the radiation quality and the depth doses obtainable with it. But we should remember that partly filtered radiation beams, which are not filtered to have a constant absorption coefficient or a straight semilogarithmic absorption curve, are not of the kind about which any definite or systematic information regarding their actions in the depths of tissues is known, nor will the use of them be anything but empiric.

CONCLUSIONS

1. Pulsating high voltage current gives practically complete, straight, semilogarithmic absorption curves.

2. Uniform potential current gives bent, semilogarithmic absorption curves.

3. The reasons for the variation seem to lie in the different spectral distributions of the wave length intensities in the two cases.

4. Pulsating current produces relatively greater intensities in the characteristic line area, compared with the intensity of the radiation on the short wave length side of the characteristic lines, than uniform voltage current.

5. The intensity maximum of the short wave length portion, produced by uniform voltage, changes on the wave length scale with increased filter thickness.

6. The intensity maximum of the short wave length portion produced by pulsating voltage current does not change with change of filters on the wave length scale.

7. The "average wave length," or any other interpretation of the slope of a semilogarithmic absorption curve, has a direct meaning when applied to radiation quality or depth actions only if the semilogarithmic absorption curve is a straight line.

8. Suggestions are indicated of the treatment of bent absorption curves. Work in these directions is in progress.

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DISCUSSION

DR. LAURISTON TAYLOR (Washington, D. C.): The first point to which I wish to draw attention is the shape of the copper absorption curve, which is fundamental to Dr. Mutscheller's whole discussion.

Back in 1924 he stated that in the measurement of the "average wave length" you must use a portion of the curve which is straight. I have tried for a number of years to get a straight absorption curve by any means whatever that was fair, but I have been unable to do so.

We have used standard ionization chambers and thimble chambers; we have used ma-

$$\text{Log } \frac{I_o}{I_x} = \frac{5.576 \times 10^{-22}}{W^3} + 0.05 \text{ for } 1 \text{ mm. Cu}$$

$$\text{Log } \frac{I_o}{I_x} = \frac{6.9 \times 10^{-22}}{W^3} + 1.98 \text{ for } 5 \text{ mm. Al. giving average quantum energy (9).}$$

Because all these equations are derived from experimentally proven relations, they give dependable results if they are not used beyond the critical absorption bands of the metals, and provided the absorption curve is straight and hence falling together with the tangent drawn to curve.

The most important point for discussion at this stage is whether or not the semi-logarithmic plot of absorption values against absorber thicknesses can possibly become a straight line. It is true that, on the basis of mathematical reasoning, when certain definite assumptions are made, the straight line would seem to be improbable. But it must not be forgotten that the assumptions made for the mathematical expressions are not in conformity with the actual spectrum of a composite X-ray beam.

So, for instance, we find that from an X-ray tube excited with pulsating current, when heavier filters are used, the semi-logarithmic absorption curve always is straight. The spectra then also show that the centers of gravity of the short wave length areas (*A*) do not shift and that the characteristic lines (*B*) are distinctly heavier in relation to the short wave length areas (*A*) than is found in the spectra obtained with uniform voltage.

It is, therefore, quite certain that the ratio of the two intensities of the short wave length area (*A*) against the intensities of the characteristic lines (*B*) is not the same in the two cases. If we keep in mind that the relative decrease of a radiation depends on its original intensity and its average absorption coefficient, it becomes clear that, in a band of great intensity and width, there

is a greater change of intensity distribution after heavy filtration than in a band of relatively lower intensity. Hence, it would be likely that we should find the ratio of the intensities of areas *A* and *B* changing differently if these intensity ratios are unequal at in the two experimental cases.

But, in addition to this, the absorption coefficients of the filtered short wave length areas (*A*) gradually shift to smaller values, and thus the transmission ratio is made still more non-uniform. In such a case, the semi-logarithmic absorption curve must remain curved, for the resulting intensity ratio would change continually with increasing filter thicknesses.³

From the foregoing, therefore, we have to draw the conclusion that the straight line absorption curve is not only possible, but that it has a definite significance and that it can be definitely interpreted in indicating depth doses in copper or in other substances. In this case, all the expectations for the value of the average wave length are realized.

For, if the absorption curve is not a straight line, then the average wave length, for indicating depth doses, loses its significance because it is unable to indicate intensities through greater filter thicknesses or other desirable factors such as depth doses in water or tissues. In fact all the information that the average wave length conveys is what sort of radiation complex falls upon the surface of the skin and how it may affect the immediate surface layers. But because the absorption curve bends away from the tangent, it can say nothing about any depth dose or effects produced at the greater depths in the absorber. Therefore, the general conclusions on the value of the

³In a private communication, Schwarzschild states that he derived an expression for the rate of change of the average absorption coefficient ($\bar{\mu}$) for two homogeneous beams. If r is the ratio of the energies in the two wave length bands, then the rate of change of the average absorption coefficients ($\bar{\mu}$) with increasing filter thickness is proportional to $\frac{r}{(r-1)^2}$.

slope of a tangent to an absorption curve are only conditionally justified, *i.e.*, in that case alone when the absorption curve is a straight line.

From this it follows that the bent absorption curve cannot be interpreted, with respect to radiation quality or depth doses, except by further treatment either mathematically, to account for the deviation of the absorption curve from the straight tangent, or by special filters, perhaps combinations of several metals through which straight line semilogarithmic absorption curves are obtained.

Then, in that case, the slope of a tangent, or the average wave length, has a definite meaning in that it definitely describes the radiation quality and the depth doses obtainable with it. But we should remember that partly filtered radiation beams, which are not filtered to have a constant absorption coefficient or a straight semilogarithmic absorption curve, are not of the kind about which any definite or systematic information regarding their actions in the depths of tissues is known, nor will the use of them be anything but empiric.

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1. Pulsating high voltage current gives practically complete, straight, semilogarithmic absorption curves.

2. Uniform potential current gives bent, semilogarithmic absorption curves.

3. The reasons for the variation seem to lie in the different spectral distributions of the wave length intensities in the two cases.

4. Pulsating current produces relatively greater intensities in the characteristic line area, compared with the intensity of the radiation on the short wave length side of the characteristic lines, than uniform voltage current.

5. The intensity maximum of the short wave length portion, produced by uniform voltage, changes on the wave length scale with increased filter thickness.

6. The intensity maximum of the short wave length portion produced by pulsating voltage current does not change with change of filters on the wave length scale.

7. The "average wave length," or any other interpretation of the slope of a semilogarithmic absorption curve, has a direct meaning when applied to radiation quality or depth actions only if the semilogarithmic absorption curve is a straight line.

8. Suggestions are indicated of the treatment of bent absorption curves. Work in these directions is in progress.

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DISCUSSION

DR. LAURISTON TAYLOR (Washington, D. C.): The first point to which I wish to draw attention is the shape of the copper absorption curve, which is fundamental to Dr. Mutscheller's whole discussion.

Back in 1924 he stated that in the measurement of the "average wave length" you must use a portion of the curve which is straight. I have tried for a number of years to get a straight absorption curve by any means whatever that was fair, but I have been unable to do so.

We have used standard ionization chambers and thimble chambers; we have used ma-

chines of every make that is found in the market, and invariably the curve is non-rectilinear over any portion of its length, even in carrying the filtration up to 3 mm. of copper.

There is a possibility that the straight line which was shown in one of the slides might be attributed to uncorrected wall effect, or some such factor, in the thimble chamber with which the measurements were made. However, I understand that this has been taken into consideration. I might say that, when making measurements with thimble chambers, we do occasionally get points through which you might draw a straight line if you want to regard the points as being badly scattered.

To-day Dr. Mutscheller brought out the point that the absorption curves become straight only for mechanical rectifiers, stating that his early work was done with mechanical rectifiers; that to-day, working with constant potential machines, the absorption curves are curved throughout. I am a little bit confused by this because, as I say, I have been unable ever to obtain a straight line relationship and I cannot see, myself, why we should expect any very nice balancing of the radiation intensities in the line radiation and in the short wave length radiation which would bring about such a condition as that. It could be very nice if it worked out that way, but it does not very often do that.

The average wave length, as Dr. Mutscheller has described it, was originally limited to a portion of the absorption curve that was straight. That was later extended, I believe, without very much explanation, to portions of the curve that were not straight, namely, below the point at which so-called "homogeneity filtration" was reached. In a paper from Memorial Hospital and in one from the Bureau of Standards, in which these relationships were discussed, the slope of the absorption curve was referred to as the effective wave length. I believe the Bureau publication calls it "true wave length" to distinguish it from Duane's "finite" filter wave length.

Fundamentally, the average wave length, as Dr. Mutscheller is now using the term—namely, the slope of the tangent at any point of the absorption curve—is none other than

the true effective wave length, which has been known for many years.

The statement is also made that average wave length, obtained as he does it, is independent of the particular filter material used for making the measurement. He also states that average wave length and effective wave length are identical when you deal with slope of the curve. We have made a great many measurements in which we have talked in terms of effective wave length, using copper, zinc, and aluminum for determining the average or effective wave length, and in no case have we ever obtained agreement between two metals.

For example, if you plot a semilogarithmic curve, say, for aluminum, that is the log of $\frac{I}{I_0}$ against increasing copper filtration, the slope of this curve as shown in Dr. Mutscheller's paper gives you the effective wave length as obtained from data on the absorption of X-rays in aluminum.

If you start, say, at a middle point and add copper filtration, you will obtain a second curve which drops below the first, and by the same method as above you can draw a tangent to this curve at the point, or approximately at the point, of intersection there. The curvature is not very great, so that you can get the tangent very accurately and from that tangent you get an effective wave length of the radiation corresponding to that point.

By a tangent method, exactly the same method in both cases, you can do the same thing, using zinc, and you will get three different values of the effective wave length—widely different values, too, except for certain accidental cases. If radiation is pretty well filtered to begin with, those methods are all going to be widely divergent.

Dr. Mutscheller has also stated that, when you use the average wave length, you are obtaining a measurement which is proportional to the depth dose of the radiation from which the average wave length is obtained. That is very true and that is a point which I want to strengthen, but there again it is not a thing which is limited to average wave length.

The semilogarithmic absorption relationship does not need to become straight in order to give a factor which is proportionate to the depth dose. If we have two semilogarithmic absorption curves, one at 140 K.V. and one at 200 K.V., we can match two portions of those curves—the 140 K.V. curve, say, above 0.7 mm. of copper and the 200 K.V. curve above 0.3 mm. of copper; we find that above those points the two curves can be made to coincide.

We also find that everything else about those radiations coincides to a fair degree, not exactly, but the depth dose relationships for the remaining radiations are very similar, which is what Dr. Mutscheller pointed out as being one of the main factors in favor of using the average wave length.

The principal point that I want to bring out is this: we have in this country now many different methods for measuring quality. We have six different brands of effective wave length, and we have a half value layer of aluminum and copper, and we have the average wave length. The unfortunate thing about it is that none of these quality measurements is in any simple way comparable.

As a result, Dr. A measures an effective wave length using 0.25 mm. Cu, and Dr. B measures average wave length, and Dr. C uses 0.5 mm. layer of aluminum. When they publish their results, you find they might as well give sphere gap and milliamperes (and guess at the distance between the sphere gap as far as obtaining any real benefit from the measurement is concerned).

The thing that seems to me to be of utmost importance is not to have so many methods for measuring quality. The average wave length is not fundamentally different from effective wave length, which has been known for a great many years. The half value layer is used almost entirely in Europe with the result that at the Congress in Paris it was decided to use only the half value layer method for international purposes. The sole reason for doing that was not because they thought the half value layer method really better than others, but simply to get rid of all the others and have only one method, however poor it

may be, so that we may all talk in the same terms.

I do not wish to discourage constructive ideas, but I do think that in putting forth these ideas we should not confuse those which we already have, and I think that is what is taking place in the average wave length measurement.

DR. ERNST A. POHLE (Madison, Wisconsin): Dr. Taylor has discussed in detail the physical points in this paper so that there are only a few words left for me to say from the standpoint of the radiologist.

We all would like very much to see one factor to express quality, one factor which is simple to determine. I have for some years advocated the effective wave length as proposed by Duane, for the sole reason that it takes only two readings with an ionization instrument and then the use of this author's chart.

However, I have also come to the conclusion, after comparing all the data which I have accumulated and classified for the past six years, that there is no single factor at present, much as we would like to have it, that can express quality with accuracy. I have come to the decision that the only thing to recommend at present is to plot a complete absorption curve and let this curve, as such, stand for the expression of quality. That means, of course, more work in determining it but it is, to my knowledge, the only accurate way of defining quality. From that curve, one may of course easily derive quality factors, such as the absorption coefficient, the true effective wave length, and the half value layer.

DR. G. FAILLA (New York, N. Y.): I think Dr. Pohle has pointed out that it is difficult to express completely the quality of radiation. One factor alone is not sufficient, whether that factor be the effective wave length, or the average wave length, or the absorption coefficient, or the half value layer. It cannot be expressed by specifying only one of those factors.

For practical purposes, if it is a question of determining the depth dose from the knowledge of one of these factors, any one of them

will do that with fair accuracy. The reason is that in a depth dose determination one is dealing with absorption in a medium of low atomic weight, as water and tissues, which are essentially, or largely, water. In this case, it is not so much the absorption of radiation in the water as the scattering of the radiation by the water, which decreases the intensity as one goes down into the deeper layers, and the scattering does not vary much for different qualities of radiation within reasonable limits.

The depth dose does not change very much when the quality of radiation is changed to a considerable extent; therefore, any one of these factors can be used. One may be a little better than another, but they all will give results which are within the limits of practical requirements.

The principle of the instrument which Dr. Mutscheller has described is the same as that of the mecapion—a German instrument—the only difference being that, instead of using the ordinary vacuum tube, Dr. Mutscheller uses a “trigger” tube.

On the other hand, the instrument depends on an increase in voltage on the grid of this tube, and, therefore, its insulation and the insulation of the condenser, which is across the tube, will influence the calibration of the instrument. The method of measurement is one in which the characteristics of the tube and the characteristics of the condenser used for varying the sensitivity of the instrument will influence the reading.

This difficulty is overcome by incorporating a uranium standard which enables one to calibrate the instrument at any time. But, of course, this introduces an additional operation in the use of the instrument.

DR. ROY KEGERREIS (Chicago, Ill.): Dr. Mutscheller was the first one to suggest the average wave length as a criterion for measurement, so far as I know, and I think he should be complimented now, since others are taking up the ideas which he expounded earlier.

While a complete calibration should be made when a new machine is put in service,

most calibrations are made merely to determine if a machine is performing as it did previously. In such a case, practically any method of calibration will be satisfactory if it is carefully done.

DR. R. R. NEWELL (San Francisco): Will we be able to persuade therapists to use rays which will give a straight line absorption curve? Will they increase their filter to that point?

DR. MUTSCHELLER: It is not a question of increasing the filter to a greater thickness; it is a question of combining different metals, probably.

DR. NEWELL: You said that a single figure would give a measure of the quality if the absorption curve is a straight line.

DR. MUTSCHELLER: Yes.

DR. NEWELL: But if the therapists insist on using a thinner filter than that, then it cannot be specified with one figure.

DR. MUTSCHELLER: No. I might add that this one figure on the probable curve applies only to a very small thickness. As soon as you get filter down into the body tissues, conditions change—we do not know in what relation.

DR. R. R. NEWELL (San Francisco, Calif.): I think that by the time six of us have said so, it will become rather well understood that no single measure—no single number—can give a measure of quality. If we wish a complete comparison of quality between two different radiations, we must have their complete spectrograms.

As clinicians, we are interested in the quality of X-rays for two purposes: one, to discover the distribution of energy in the tissues of the patient; and the other, to discover the quality which is acting on the cells, for it is still possible that different wave lengths give different biologic effects.

We are now talking about radiations which are produced at moderately high voltages and filtered through moderately heavy copper filters, those of 0.5 mm. or more. If we limit our discussion to such radiation, we will see

that the increase in hardness due to further filtration in the tissues is entirely negligible compared with the increasing softness of the average radiation in the tissue from the addition of scattered ray (Compton effect).

The consequence is that, when we apply a filtered ray of an average wave length of 0.15 to the surface of a woman's pelvis, we find the average wave length which penetrates into her uterus is not harder on account of the filtration of her body, but very much softer. It may be as soft as 0.2 average effective wave length by the time it gets into the middle of her pelvis.

Why be ultra-precise about the spectral composition of an X-ray beam when it will have that composition markedly altered in uncertain degree by the reaction of the patient upon it? I would be perfectly contented, for medical records, with the specification of wave length by any of these methods: (1) half absorption thickness in copper; or (2) half absorption thickness in aluminum; or (3) average wave length, which is the tangent of the absorption curve line; or (4) mean effective wave length.

Or I should be quite content with this restriction: that one stated he was using a half-wave, or a mechanically rectified machine, or a constant potential machine, and specified the voltage indicated by the sphere gap. I think any of those is sufficiently close for medical records—not for physical record, but for medical records; I think we are making a great deal of ado over a very small difference.

DR. MUTSCHELLER (closing): There are, of course, many things that I have not mentioned because the discussion would have become entirely too long. I believe that this omission is responsible for part of the trouble under which Dr. Taylor is laboring.

When I say "straight" absorption curve then we have to consider the lower end. The first, or upper, part of an absorption curve is always bent and according to conditions the bend diminishes until the curve finally approaches a straight line. For practical purposes, therefore, the bend becomes gradually

less and less so that we can assume it to have approached a straight line.

I can take some of Dr. Taylor's curves and I am satisfied that they are straight lines within the zone within which I would use them. But there is one point that limits our discussion and that is, if you go to still heavier filters than 2 mm. Cu, then conditions may change. Then the characteristic lines begin to disappear from the spectrum and we have only the short wave length end of the spectrum left. From that point on, of necessity, the curve must bend again. Therefore, the straightness, or the straight characteristic, is one which is not complete but which is only approached as we continue filtering.

I am surprised that Dr. Taylor did get different numerical values when using various metals for determining the average wave length, but there must be an error involved, because this is necessarily so theoretically. In practice I am obtaining exactly the same numerical value for the average wave length irrespective of whether I use, for instance, aluminum or copper.

Of course, that means that the ratios of intensities must be interpreted by the relations which I derived and which are based absolutely on experimental facts. I say again I do not know why he does not get the same numerical values with the two metals. There must be an error of some kind.

Now if we come down to the practical side of this question, this point arises: that the half value layer method and the effective wave length method as described by Duane (he for the first time used the expression "effective wave length") are secants to an absorption curve and that is entirely different from what we call the average wave length, which is a tangent, an entirely different thing, and we have to keep them apart.

Of course, of these three quality designations only the average wave length gives one numerical value. With the others you can get any numerical value that you care to get, by simply using a different filter thickness or a different metal, and with each one of them you will get a different value.

Dr. Newell appears rather easily pleased, but I believe I have to state that these efforts are really the first step in an attempt to evolve finally a method which gives us under all circumstances one definite numerical value as a description of the radiation quality. At this time I am making the bold statement that one numerical value describes fully the radiation quality if the absorption curve is a straight line. I am in a position to prove that.

But at the moment when the absorption

curve is bent, then we lose control over the situation. For that reason I am stressing the straight absorption curve because there are possibilities that we may be able to use such filter combinations as will ultimately give the straight absorption curves. Then we will have the situation clear; we will be able to calculate, and we will have made a distinct step in advance insofar as we can describe radiation by only one figure, and that will be the ultimate aim.

THE ANNUAL MEETING

(Continued from Page 31)

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By ERNEST KRAFT, M.D., NEW YORK CITY

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An excellent review of the first seven cases³ was published by Léri and Lièvre (10) in 1928. In another publication (8) I referred to a total of 16 cases. Two additional cases⁴ were reported by Rokhlin (23) and Weil and Weismann-Netter (28).

¹Read by title before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

²The writer is indebted to several authors for their reproductions, to Dr. I. S. Hirsch for advice, and to Dr. E. B. Coolley and others for co-operation.

²Among these, the 22) does not appear entirely typical. Exhaustive histologic studies have caused a widespread misconception and the formation of an etiologic theory.

*These reports have been added since the paper was prepared for publication.

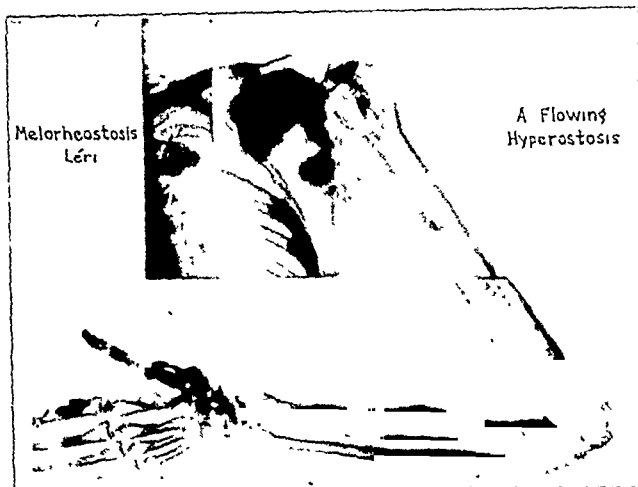


Fig. 1. Complete continuous hyperostotic flow from shoulder to phalanges. Ankylosis of first and second carpometacarpal joints. Bowing deformity of proximal ulna. Arrows point to hyperostosis of cartilaginous junction of first rib. Numerous heterotopic formations in axilla and below clavicle. The lesions have been slowly progressive for 19 years and seem to have developed from a circumscribed and interrupted flow. (Personal observation.)

the hip to the foot. Radiographs taken in 1922 revealed eburnation of the femur. The other case, shown by Dr. B. M. Parmelee, Bridgeport, Conn., was a woman, aged 23 years, who had suffered from rheumatic pain of the right hip for five years. The symptoms increased in severity following a childbirth. The radiographic examination disclosed a complete continuous flow of hyperostosis extending from the right sacroiliac area to the phalanges. Dr. Sherwood Moore, of St. Louis, saw a case of melorheostosis in a middle-aged woman, who apparently had a circumscribed affection of a fibula. Another case was observed by Dr. Sante, of St. Louis, about ten years ago. Dr. Sante sent me his reproductions and permitted me to utilize his material. In his case, the hyperostosis was limited to the fourth right metacarpal and adjacent phalanx (Fig. 8). No other films were made.

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SUMMARY OF 19 CASES OF MELORHEOSTOSIS*

Number	Authors	Affected extremity	Extent of lesions (See classification in "Pathology")	Sex	Reported in	Age of		Histologic studies
						Pa-tient	Onset	
1	Léri-Joanny	Left upper	Complete continuous flow	Female	1922	39	10	+
2	Lewin-McLeod	Right upper	Partial continuous flow	Male	1925	35	6	
3	Muzii (19)-Putti	Left lower	Complete continuous flow	Female	1926	10	5	
4	Putti	Left lower	Interrupted flow	Female	1927	8	7	+
5	Zimmer	Left lower	Interrupted flow	Male	1927	32	21	+
6	Perussia-Meda (14)	Right upper	Complete continuous flow	Not stated	1927	
7	Valentin (26)	Right upper	Complete continuous flow	Female	1928	17	15	
8	Meisels (15)	Right lower	Interrupted flow	Female	1928	25	21	
9	Kemkes (7)	Right upper	Complete continuous flow	Male	1929	54	42	
10	Milani (18)	Right lower	Interrupted flow	Male	1930	
11	Léri-Loiseleur-Lièvre	Right upper	First: circumscribed flow Later: interrupted flow	Male	1930	39	29	+
12	Kahlstorf (5)	Left lower	Interrupted flow	Male	1930	33	30	
13	Junghagen	Right upper	Interrupted flow	Male	1930	+
14	Piergrossi	Right lower	Interrupted flow	Male	1931	36	14	
15	Rokhlin	Left upper	Interrupted flow	Female	1931	25	14	
16	Weil-Weismann-Netter	Right upper	Interrupted flow	Male	1932	37	22	
17	Kraft	Left upper	Complete continuous flow	Male	1932	40	22	
18	Geschickter-Miller-Kraft	Right lower	Partial continuous flow	Female	1932	37	23	
19	Sante	Right upper	Circumscribed flow	Male	

*Five cases are reported from Italy, four from the United States, three each from France and Germany, and one case each from Poland, Switzerland, Sweden, and Russia. There is a predominance of males (11:7) and of the right side (12:7).

nodule on the lateral chest wall opposite the side of the affected limb. This node, however, was not radiopaque and did not show the typical features of hyperostosis.

The circumscribed appearance in Sante's case has influenced me to classify the cases according to the extent of the lesions. I differentiate between:

1. Complete continuous flow (far-advanced stage).
2. Partial continuous flow (advanced stage).
3. Interrupted flow (advanced stage).
4. Circumscribed flow (early stage).

It is my belief that the four groups merely represent different stages in the progress of the disease. As the lesions continue to spread, a case may easily change from one group to another. The progressive nature

is clearly indicated by the characteristic histories and, in the case of Léri, Loiseleur, and Lièvre (cited below), by radiographic proof.

Group 1. In a few cases, the hyperostosis is spread over the entire extremity (Figs. 1 and 2). Dense, ivory-like cortical proliferations extend as a *complete continuous flow* from the shoulder down to the fingers. Such hyperostosis, which is confined to one side of a bone, unless far advanced, seems to follow the course of vessels and nerves without actual relationship. The hyperplastic material shows an irregular wavy contour, with numerous small ridges parallel to the long axis of the bone. Léri compared the masses with the molten stream of a candle.

Group 2. The *partial continuous flow*

and the patient could not be communicated with again.

In the following table Dr. Sante's case is included as the nineteenth, but no claim is made as to the completeness of the list.⁵



Fig. 2. Same case as shown in Figure 1. Anteroposterior view of left elbow. The joint is not involved, although the adjacent bones show a continuous hyperostotic flow.

PATHOLOGY

Knowledge of the pathology is derived solely from X-ray examination, and, in five cases, from biopsy studies. As yet, no cases have come to autopsy.

The lesion consists of a dense cortical hy-

perostosis, resembling sclerotic bone. Such a lesion is expansive, causing an enlargement of the affected part, and extending in a linear track in the form of a longitudinal band, like a hyperostotic "flow." Several authors

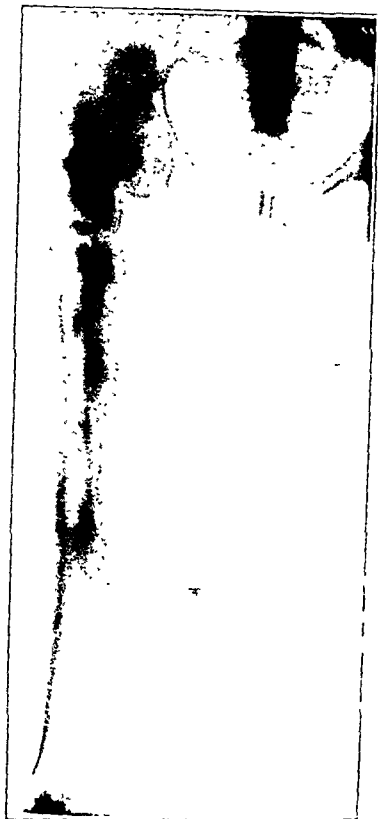


Fig. 3. Extensive hyperostosis is confined to hip and femur, being classified as partial continuous flow. The hip joint is ankylosed and heterotopic masses are seen above the acetabulum. Slow progress observed over 14 years. (Case of Geschickter, Miller, and Kraft.)

observed dense zones of eburnation in the cortex of long bones with encroachment upon the medulla. In the 19 cases described, the changes were confined to a single extremity, either upper or lower.⁶ In his first case Léri found an isolated

⁵Almost two years ago, the writer heard of observations in Australia, but he was unable to verify statements in spite of a communication with Dr. Colin McDonald, of Melbourne.

⁶The tendency of the lesions to involve only a single extremity is unique among bone diseases, with the possible exception of Ollier's chondrodysplasia. The idea that this latter condition is a separate entity is, however, seriously contested according to the review of Bromer and John (1).



Fig 6 The flow is fairly continuous from hip to knee, but is interrupted in leg and foot. Heterotopic hyperostosis is seen in inguinal region, resembling the subclavicular formations in Figure 1. In contrast to findings on Figure 3, the lateral portion of the femur is involved, thus being the most frequent type of femoral affection (Case of Meisels)

HISTOLOGY

Biopsy material was studied in five cases. The tissues were poor in cells and devoid of osteoblastic activity. An increase in osteoblasts was described by Lévi. The osseous lamellæ showed compactness, marked crowding, elongation, and irregular arrangement in various angles. Junghagen (4) always noted a concentric grouping of lamellæ around the haversian canals (Fig 10). In the heterotopic masses, islands of cartilage were observed by Lévi and Roussy (24). The fat marrow in the canals was transformed into fibrous tissue, but the capillaries were found to be normal in most instances. Putti, however, described a vascular abundancy with obliteration of capillaries. On reporting the histologic findings of Zimmer's case, Kauffmann (6) stated that the sections did not present sufficient

characteristic features from which to make a diagnosis of melorheostosis.

SYMPTOMATOLOGY

The symptoms are characterized by an insidious onset and slow manifestation. Owing to the fact that the findings are sometimes incidental in the course of routine examinations, one may consider a small group as quiescent. Patients with symptoms complain of low-grade, intermittent rheumatic pain which sometimes disappears for months, and even years, although the lesions may be progressive. Usually the complaints are rather vague, even when the joints become involved.

In the advanced cases, bowing deformities^b of bones occur which may result in shortening of the limb. The muscles tend to become at-



Fig 7 Same case as shown in Figure 6. The hyperostotic flow is confined to the distal fibula, being interrupted in the tibia and proximal fibula. Tarsals and metatarsals in this case are also involved.

^bWith the exception of Putti's second case, the convexity of the curved bones has always been found on the side of the hyperostosis.

is characterized by the same features as the first group, but one-half of the extremity remains intact. Figure 3 illustrates such a condition of the proximal parts of a lower extremity, the lesions having remained fair-

which has changed from a circumscribed to an interrupted flow under actual radiographic control.

Piergrossi (21) differentiates between two successive phases of development. In



Fig. 4 (left). Partial continuous flow involves the ulna, triquetrum, pisiforme, capitate, hamate, metacarpals, and phalanges of fourth and fifth fingers. Ankylosis of carpometacarpal joints. (Case of Lewin and McLeod.)

Fig. 5 (right). Same case as shown in Figure 4. The hyperostosis is sharply confined to one side of the bones. Note irregular borders, spur formations, and bowing deformities. The history dates back 29 years to the age of 6.

ly stationary for 14 years, without developing into a complete continuous flow. In the case of Lewin and McLeod (Figs. 4 and 5), only the distal parts of an upper extremity are involved, in spite of a pathologic history of 35 years' duration.

Group 3. The *flow*, although spread over an entire extremity, is sometimes *interrupted* in several places (15, 16, 17; Figs. 6 and 7).

Group 4. A *circumscribed flow* was described above in the case of Sante (Fig. 8). The hyperostosis, which was confined to one metacarpal and contiguous phalanx, presented a fairly regular contour. The process remained stationary during an observation of 21 months. A condition similar to this, but further advanced, is illustrated in Figure 9 (12), in which the previously normal humerus has become hyperostotic in the course of years. This is the only case

the first, there is mainly osteosclerosis, slight enlargement, and fairly regular outline of bones. The second phase, as seen in adults, is characterized by considerable irregular enlargement, supposedly due to periosteal proliferation.⁷

The lesions usually spare the joints: only in advanced cases may one find an ankylosis (Figs. 1, 3, and 4). The affected bones are very compact and have no tendency to fracture, in contrast to the somewhat similar marble bone disease.

When the shoulders or hips are affected, bony masses appear frequently in the soft parts, lodging in muscles, and sometimes bulging under the skin. These heterotopic formations are of bizarre appearance and partly confluent (Figs. 1, 3, and 6).

⁷The first phase corresponds to the circumscribed flow, the second, more or less to the interrupted and continuous flow. However, one may see both phases in different parts of the affected extremity. The periosteal changes cited by Piergrossi and others are of doubtful significance.



Fig 9. The lesions are further advanced than those shown in Figure 8. Arrows indicate the seat of hyperostosis. Slow progress, observed over 10 years, resulted in marked involvement of the previously normal humerus. (Case of Léri, Loiseau, and Lièvre.)

there has been no proof, in spite of elaborate experiments. Putti believes that a lesion of the sympathetic system produces certain vascular changes, with subsequent eburnation of bone along the course of nutrient vessels. Constitutional, endocrine, and hereditary factors are of doubtful importance. There is no reason to believe that the disease has any connection with syphilis, tuberculosis, or malignant neoplasms.

Several authors tried to explain the linear distribution of the hyperostosis by assuming a lesion of a truncal segment during early embryonic life. In discussing Lewin's presentation in 1925, Phemister (20) suggested such a possibility. Lewin and McLeod mentioned the possibility of a lesion of spinal ganglionic origin, with involvement of segments. On the same basis, Zimmer (29) formulated the embryonic



Fig 10 Biopsy section (case of Junghagen) taken from eburnized olecranon. Narrowness, irregular arrangement, and elongation of osseous lamellæ. No evidence of osteoblasts or vascular changes.

theory of a metameric disturbance. His views were discussed in a previous article (8).

Certain cases in which the root of an extremity is extensively involved seem to support Zimmer's theory. However, our present knowledge of the origin and development of limbs is not in accord with these explanations and, in my opinion, it is better to admit that the nature of the disease is still unknown.

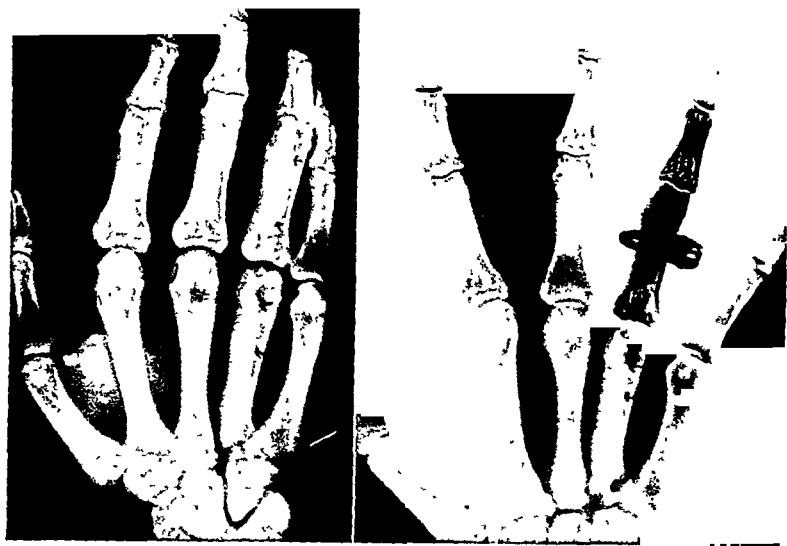
TERMINOLOGY

Various names have been applied to characterize the disease: Osteopathia hyperostotica congenita unius membri, osteosis eburnisans monomelica, Léri's disease, and melorheostosis Léri. In a recent article, Weil and Weismann-Netter proposed to change "melorheostosis" to "rheostosis" because, in their case, not only the limb (melos), but also the fourth rib and thoracic vertebra on the same side were hyperostotic, *e.g.*, parts of the skeleton apparently outside of the affected extremity. Their findings,

rophic; at times circumscribed erythema and nodular induration occur in the skin of the affected extremity. The first symptoms usually appear during childhood, but they are vague, and many years may elapse be-

oplasm can be disregarded in view of different physical findings.

In cases with a complete continuous and with an interrupted flow the correct diagnosis is obvious. The partial continuous



Figs. 8-A (left) and 8-B (right). Circumscribed flow of fourth metacarpal and contiguous phalanx (marked by arrows). Fig. 8-A was taken in January, 1921; Fig. 8-B, taken 21 months later, demonstrates a stationary condition. (Case of Sante.)

fore deformities of the fingers (Fig. 11) and limited motion of joints cause the patient to consult a physician. In advanced cases, mechanical interference at important joints may cause some disability, but unless patients suffer intercurrent or incidental diseases, they remain in good health.

The physical and laboratory findings are irrelevant.

There is no known treatment for the condition. Spontaneous arrest of progress may occur at any time.

DIFFERENTIAL DIAGNOSIS

The specific findings and clinical features described in the previous sections are helpful in ruling out similar lesions. In order to eliminate the possibility of a syphilitic disorder, serologic tests are essential. Tuberculosis and primary or metastatic ne-

and the circumscribed flow have to be differentiated from ossifying periostitis, calcinosis, marble bone disease, Paget's disease, sclerosing osteitis, osteopoikilosis, calcified hematoma, especially in hemophiliacs, and from other affections.

As to whether or not the unilateral involvement as seen in 23 cases is a definite criterion in the differential diagnosis cannot be decided with certainty according to our present knowledge, but it is an outstanding feature of the disease. Whenever a case presents lesions resembling melorheostosis in multiple extremities a very critical consideration of the differential diagnosis is necessary.

ETIOLOGY

Léri advanced the theory that the lesions might be of an infectious nature, but so far

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DISCUSSION

(Continued from Page 13)

side of the forehead and face which had gradually become more noticeable. For six months he had had severe convulsive attacks during which he became unconscious and bit his tongue. Roentgenograms made after his admission to the hospital showed a marked thickening of both frontals and, to some extent, both sphenoids. The right frontal sinus was filled with a dense, bony material. As he had a 4 plus Wassermann, he was regarded as a syphilitic patient. In spite of active anti-syphilitic treatment, the tumor continued to increase in size, the convulsions became more frequent, and the headaches more intense. A

decompression was performed and the same treatment administered for two months longer, but with no improvement. The specimen removed at operation was reported as an osteitis fibrosa cystica.

Three months after the beginning of the anti-syphilitic treatment, the roentgenograms showed the process to have increased in extent. The patient was then given roentgenotherapy. At the conclusion of this, he was sent home, slightly improved. Three months later his symptoms had almost completely disappeared. The tumor was somewhat smaller. Six months later the tumor had disappeared and the patient felt perfectly well. He has not reported since.

however, are comparable to those of other cases in which large portions of the scapula, ribs, and pelvic bones, including the fifth lumbar vertebra, are involved and are referable to the root (anlage) of an extremity.

definitely proved. Microscopically, the tissues do not present specific features.

4. The disease is slowly progressive, but it may become stationary in the early, as well as in the late, stage for many years.



Fig. 11. Same case as shown in Figures 1 and 2. Left thumb and index finger show gross deformities, with multiple bony lumps bulging under the skin. The thumb is held in mid-position due to ankylosis. Similar deformities of fingers induced Weil and Weismann-Netter to make a tentative diagnosis of melorheostosis in their case prior to X-ray examination.

Therefore, Léri's term, "melorheostosis" or "hyperostose en coulée sur toute la longueur d'un membre" [monomelic (single limb) flowing hyperostosis], still holds good.

SUMMARY

1. Melorheostosis is a flowing hyperostosis of a single extremity. In preference to other terms, the name "monomelic flowing hyperostosis" is proposed.

2. So far 19 cases have been described in the literature. Four additional cases, not published as yet, have been seen in the United States.

3. In the early cases, the hyperostotic flow is confined to isolated parts of an extremity (circumscribed flow). In the advanced cases, the flow is either interrupted or continuous (interrupted flow, complete, and partial continuous flow). An affection of other parts of the body has never been

5. The symptoms are rheumatic pain and limited motion of joints. In most cases the complaints are vague, and ankylosis of joints may cause relatively little concern.

6. Only by X-ray examination can diagnosis be made. Occasionally, curving deformities of fingers are sufficiently characteristic to cause one to suspect the disease prior to X-ray studies.

7. The etiology is still unknown, in spite of the fact that the clinical features point toward a congenital nature. The lesions, although resembling other bone diseases, represent a separate entity and are benign in character.

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BYRON H JACKSON, M D
PRESIDENT OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

EDITORIAL

LEON J. MENVILLE, M.D. *Editor*
BUNDY ALLEN, M.D. *Associate Editor*

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Radiological Society of North America*

THE NATIONAL BOARD OF MEDICAL EXAMINERS RECOGNIZES RADIOLOGY

Radiology has, during the last few years, received deserved recognition by organized medicine. For a long time the American Medical Association was without a radiologic section, radiology being considered in the Miscellaneous Section. Through the enthusiasm and energy of Dr. Albert Soiland, of Los Angeles, the American Medical Association was brought to appreciate the important position radiology held, and a Section on Radiology was organized. This Section has been in successful operation for several years, and its popularity is attested by the large number who contribute to its programs and attend its meetings.

The Southern Medical Association has had an active Section on Radiology for several years, the importance of radiology being thus recognized by this, the second largest medical body in the United States.

It is with a modest degree of pride that RADIOLOGY, the official Journal of the Society, is able to say that it has taken an active part in the latest and one of the most important recognitions to be accorded radiology. The Journal presented in its May, 1932, issue a statistical study on the medical schools of the United States and Canada. We called the attention of the officers of the National Board of Medical Examiners to this presentation of irrefutable evidence of the progress of radiologic education, and their answer is the following communication:

NATIONAL BOARD OF MEDICAL EXAMINERS

Founded, 1915, by William L. Rodman, M.D.
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Merritte W. Ireland, M.D.
O. H. Perry, Pepper, M.D.

November 1, 1932

Dear DOCTOR MENVILLE: At a meeting of the Executive Committee of this Board held on October 23, the matter of the recognition of Radiology brought up by you in a letter to Dr. Walter E. Garrey on June 15, was presented.

I am instructed to inform you that the National Board is in sympathy with the recognition of this most important subject and will provide in its next issue of instructions to candidates which explains the contents of the examination in Part III, that questions in Radiology and the recognition of the more usual X-ray plates will be expected.

Sincerely yours,

J. S. RODMAN,
Medical Secretary

This is the very goal for which radiologists are striving—instruction to be available to medical students, so that they may enter practice with a thorough grounding in radiology, whether or not they purpose to become specialists in it. When internists and surgeons alike shall have received instruction while students as to the indications for roentgenology and the principles which govern radiation therapy, they will be the more ready to confer with other physicians who have specialized in radiology.

This recognition by the National Board of Medical Examiners will be a step in the just appreciation of the limitations of and indications for radiology, and we look for it to result in a clearer understanding of the educational requirements necessary for a physician to become a radiologist. Also, it is to be expected that fewer physicians without intensive training in the use of the X-ray and radium will undertake the employment of these agents, appreciating, rather, that they are not for inexperienced hands.

It is a matter of great satisfaction to all of us that so authoritative a body as the National Board of Medical Examiners has thus put itself on record, and is prepared to co-operate with the organized bodies of radiologists that have worked consistently for this educational recognition.

ANNOUNCEMENT

THE MINNESOTA RADIOLOGICAL SOCIETY

The Minnesota Radiological Society held its twelfth meeting at St. Luke's Hospital, Duluth, Minnesota. The following program was presented:

(1) Roentgen Findings in Pneumoconiosis, J. R. McNutt, M.D., Duluth.

(2) Roentgen Therapy in Carcinoma of the Uterine Corpus, F. B. Exner, M.D., Minneapolis.

(3) Roentgen Visualization of the Urethra, Normal and Pathological, M. H. Nicholson, M.D., Duluth.

(4) Atelectasis of the Lungs, F. Hirschboeck, M.D., Duluth.

(5) Roundtable Discussion on Problems of Roentgen Diagnosis and Therapy, conducted by Gage Clement, M.D., Duluth.

Address on Diaphragmatic Hernia: (A) Roentgen Aspect, B. R. Kirklin, M.D., Rochester; (B) Surgical Aspect, S. Harrington, M.D., Rochester.

IN MEMORIAM

HARRY THEODORE HILLSTROM

Oct. 16, 1902–Oct. 3, 1932

On Oct. 3, 1932, a career of remarkable promise was unfortunately terminated by the death of Dr. Harry Theodore Hillstrom as a result of an accident that he had sustained a short time previously. His loss is a grievous one to all of those who have been associated with him in the Vanderbilt University School of Medicine and in the Vanderbilt University Hospital.

Dr. Hillstrom was born in Carver County, Minnesota, on Oct. 16, 1902.

After obtaining an academic degree at the University of Minnesota, he entered the School of Medicine. At the age of 24, when he was in the second year of medical school, it was found that he had diabetes. The discovery of insulin gave him an opportunity to lead a happy, useful life even though he was somewhat handicapped. It is particularly distressing that a person who had the stamina to work and forge ahead despite such a malady should have lost his life so shortly after becoming well established in his chosen field.

He received his medical degree from the University of Minnesota in 1927 and occupied a position there as Teaching Fellow from 1928 to 1930. From 1930 until the time of his death he was an Assistant Professor of Surgery in charge of Radiology in the Vanderbilt Medical School.

Despite the shortness of Dr. Hillstrom's career at Vanderbilt, he made a profound and far-reaching impression. As a teacher, he was inspiring to the clinical staff of the hospital as well as to the students of the medical school. Because of his exceptional training and ability, he was able to devote himself to research and to make a number of important contributions concerning the action of X-rays. Particularly outstanding among these was a recently completed study of the effects of irradiation on the growth of bone, a work which was presented before the American Medical Association in May, 1932.

Dr. Hillstrom's unfailing courtesy and his critical acumen endeared him to his professional colleagues. He won the respect and admiration of all who were privileged to know him intimately. He was a generous and thoughtful companion, a zealous scholar, and a true gentleman. It is with the utmost sorrow that Vanderbilt University has lost one of the most valuable and beloved members of its staff, and RADIOLOGY one of its Assistant Editors.

have been reviewed in American medical literature. These have stimulated interest in this diagnostic procedure.

In briefly reporting the three cases of anencephaly which have come to my attention within the past year and a half, it is not my desire to enter into a discussion of the pathology of the fetus or a consideration of the possible factors which might be the cause of this deformity. It is interesting, however, to stress the fact that all three cases had certain features in common which would probably apply to the larger percentage of this particular type of obstetric monster.

The three mothers were referred for X-ray examination by obstetricians who, in each case, had recognized hydramnios and who had obtained a history of convulsive movements of the fetus. In each case the physicians reported inability to locate accurately the fetal head, which was immediately suggestive of the possibility of an atypical pregnancy. In all three cases, after the diagnosis of anencephaly was made, cervical dilatation was immediately accomplished by means of the hydrostatic bag, version was performed, and the fetus promptly delivered, followed by uneventful recovery of the mother.

All of the prenatal roentgenograms showed definite absence of the cranial bones, cephalic presentation and fetal size corresponding to the duration of pregnancy. The fetuses, which were born alive and breathed from one to three hours, were of the male sex and well developed, with the exception of the same cranial malformation. They had the same facial appearance, with bulging eyes and aquiline nose. Roentgenograms showed the typical absence of the cranial bones, but no pronounced spina bifida.

Case 1. A white mother, aged 24 years, primipara. The woman reported no impor-



Fig 2. Case 1. Roentgenogram of the fetus.

tant previous illness. The first menses, at 14, were painful and profuse. At the time of the present examination, the woman was eight months pregnant, but the abdomen was the size of full term. There was evident excess of amniotic fluid. Rapid increase in the size of the abdomen in the preceding three weeks had been noted.

Case 2. A white mother, age 27 years. There was no history of important illness. There was one normal child, which at birth weighed five pounds, fourteen ounces. There had been prolonged labor and a low

CASE REPORTS

THE EARLY RECOGNITION OF ANENCEPHALY, WITH A REPORT OF THREE CASES¹

By W. O. WEISKOTTEN, M.D.
SAN DIEGO, CALIFORNIA

Based on a review of roentgenologic literature covering the past 10 years, it is the opinion of the writer that there must

normal pregnancies which were denied the benefit of prenatal X-ray examination, largely because the attending physician did not recognize the indications or was not familiar with the important possibilities of this modern roentgenologic procedure in these cases. When one considers the great importance of the early diagnosis of obstet-

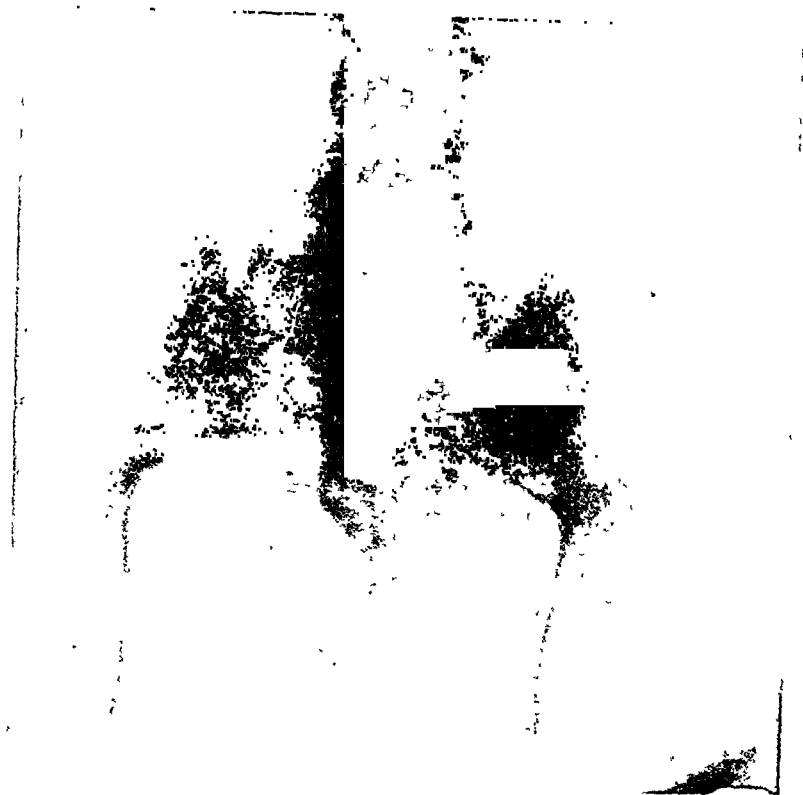


Fig. 1. Case 1. Roentgenogram of eight months' pregnancy, antero-posterior projection.

be many unreported cases of atypical pregnancy which have been properly diagnosed, prior to delivery, by means of the roentgen ray. By the same token there must have been many hundreds of ab-

normal pregnancies, more important, perhaps, when cesarean section is under consideration, the assumption seems to be justified.

Since the first published report of Case, in 1917, on the prenatal diagnosis of anencephaly, 18 cases, which were recognized by early roentgenologic examination,

¹Read before the Radiological Society of North America at the Sixteenth Annual Meeting, at Los Angeles, Dec. 1-5, 1930.

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(2) the unexpected result of the postmortem studies.

The patient, a white male, 67 years of age, was first seen in October, 1930. His chief complaints were dyspnea on exertion, which had been present for about nine



Fig. 4. Case 3. Typical anencephaly, lateral projection.

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A CASE OF INTRATHORACIC CARCINOMA PRIMARY IN THE PLEURA

By ALAN L. HART, M.D., M.Sc (Med), Roentgenologist to the Tacoma General Hospital, and DALE L. MARTIN, M.D., M.Sc., Pathologist to the Tacoma General Hospital, TACOMA, WASHINGTON

This case is presented for two reasons: (1) the bizarre roentgenologic picture, and

months, and pain in the right chest. Anorexia had been apparent for three months. A month previous to the examination, the patient had had an attack of pain in the right chest which had lasted a week. This pain had later become constant. It was exacerbated by breathing and by lying on his left side. He had lost 15 pounds in the 3 months preceding examination.

The man gave a history of the usual infectious childhood diseases, malaria for a period of three years in early manhood, and an attack of irregular, rapid heart action in 1922. Careful questioning did not reveal a history of an acute febrile illness that might have been regarded as a pneumonia, pleuritic effusion, influenza, or other serious respiratory infection. Nocturia two or three times nightly had been present for six or seven years, with increased frequency and diffi-

forceps delivery. At the time of examination of the mother, the child was two and one-half years old.

Examination showed normal pelvic measurements and normal blood pressure. The

of twins, born between these two living children, was delivered prematurely at the sixth month. The twins presented cleft palates, and one, *spina bifida*.

The present pregnancy was of seven and



Fig. 3 Case 2 Typical anencephaly, postero-anterior projection

urine and blood Wassermann examinations were negative. At five months of pregnancy, the woman had had severe cramps and a threatened miscarriage. At eight and one-half months, she was referred for X-ray examination.

Case 3. A white mother, age 32 years. The woman's general health was good, and there was no history of an important illness. The two living children, aged nine and four years, had been normal deliveries, and the health of both was good. One set

one-half months' duration, but the abdomen corresponded in size to full term. The fetus was floating and the head was not recognized by manual examination.

I wish to thank Dr. L. C. Kinney and Dr. A. E. Elliott for permission to report their case with this series and to comment on the diagnostic quality of the film which permitted so accurate a diagnosis.

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was shaken or changed his position. He left the hospital, improved, on Jan. 7, 1931.

On March 24, 1931, during an automobile ride, the patient said he did not feel well and suddenly collapsed. He was brought to the hospital, but he was found to be dead. Films of the chest were made and an autopsy performed at once.

When the thorax was opened, a large pleural pocket, containing 2,000 c.c. of clear, serous fluid, was found in the right side, occupying the lateral and posterior portion of the right chest. Crossing the cavity were several firm, fibrous, band-like adhesions. The wall of the pocket was thick and yellowish, exuding an apparently purulent material. The left chest was normal except for a few old, fibrous adhesions about the base of the lung. There were apical scars in both lungs and calcified hilum nodes. The heart appeared normal.

The entire lower portion of the right lung was leathery in consistency. Crepitation was absent. The pulmonary surface that bordered the empyema cavity was dark blue in color, and studded with many small, white, elevated nodules less than 1 mm. in diameter. Upon microscopic section, these tiny nodules were found to be carcinoma; the greatly thickened parietal pleura was also carcinomatous.

There were 50 c.c. of free fluid in the abdomen. An old, fibrous band extended from the gall bladder to the hepatic flexure of the colon. There were several pedunculated polypi in the colon, averaging 1.5 cm. in diameter. The prostate was enlarged, Grade II, but was soft and smooth. There were no other gross findings of note.

The histologic characteristics of the sections were clearly those of carcinoma rather than endothelioma. Microscopic section of the lung, including the pleura lining the intrathoracic mass, showed the surface to be covered by several layers of loosely and irregularly arranged cells, apparently epithe-



Fig. 2 Lateral film of the chest. The ascending aorta and horizontal arch are distinctly outlined above the mass.

lial. The infiltration generally was rather uniform with only an occasional alveolar area. The cells were irregular in size, larger than the ordinary endothelial cell, and showed a well stained cytoplasm. The nuclei were moderately hyperchromatic and mitoses were present. Though the epithelial coat was very shallow, it was more than a simple inflammatory hyperplasia. Beneath the pleural surface, the lung showed atelectasis, but no neoplastic change. The remainder of the pulmonary parenchyma was free from carcinoma.

Sections of the parietal wall of the pleural pocket showed a picture similar to that of the lung, except that the process was deeper, being seen among the muscle bundles of the thoracic wall. The cells were in broad masses, usually parallel to the surface, with an occasional alveolar group. In the latter areas, the cells lining the alveoli were rarely one layer deep.



Fig. 1. Film of the chest made at the time of first examination. A roentgenogram made at time of death showed no apparent change. Note the complete obliteration of all lung detail and the diaphragm by the large mass in the right chest.

Rectal examination showed a moderately enlarged prostate, smooth, and not unusually firm.

X-ray Examination.—Roentgenograms of the chest (Figs. 1 and 2) showed a dense opacity occupying the lower two-thirds of the right lung field, obliterating all lung detail, and completely obscuring the right diaphragm. The upper third of the right lung and the entire left lung were clear. The ascending aorta and the horizontal arch were distinctly outlined above the shadow, on the lateral view; the descending aorta was entirely obscured. Diagnosis was a probable tumor involving the right lower and middle lobes. The condition was also considered as possibly due to either encapsulated pleural fluid or aneurysm of the descending aorta with atelectasis of the lower and middle lobes.

The patient refused hospitalization, stating that he felt better when ambulant and that he did not consider himself really ill. Although it was advised, thoracentesis was not done.

culty in starting the stream for two or three years previous to this report.

Physical Examination.—Temperature, normal. Pulse, from 75 to 80. Respiration, 20. Blood pressure, 132/94. All teeth had been removed. The head and neck were otherwise negative.

The left chest was emphysematous and hyperresonant throughout. Percussion note over the right chest was dull below the fifth rib in the posterior axillary line and the fourth rib anteriorly. Over this area, breath sounds were absent except along the border of the sternum, and vocal and tactile fremitus were greatly decreased. The right chest showed very little respiratory movement. The left border of the heart was at the anterior axillary line, with the maximum impulse sharply localized just to the left of the midclavicular line. The A² was sharply accentuated, but there were no thrills or murmurs. The abdomen was apparently normal.

On Jan. 4, 1931, the man was re-admitted to the hospital with a greatly distended bladder and complete urinary suppression which had lasted for 24 hours. After the acute condition had been relieved, the patient stated that he felt better than when we had examined him 10 weeks before, but that he had lost 30 pounds since July, 1930.

While he was in the hospital, his temperature range was from 98 to 99 degrees, the pulse, from 100 to 75. Wassermann and Kahn tests were negative. The urine showed a trace of albumin, a few pus cells, and a few red blood cells. Blood count: red blood cells, 5,000,000; white blood cells, 8,000; hemoglobin, 13.5 gm. (81 per cent); differential white count, normal.

Roentgen examination of the chest showed no change in the appearance of the right thorax. There was no pulsation in the mass and no movement when the patient

was shaken or changed his position. He left the hospital, improved, on Jan. 7, 1931.

On March 24, 1931, during an automobile ride, the patient said he did not feel well and suddenly collapsed. He was brought to the hospital, but he was found to be dead. Films of the chest were made and an autopsy performed at once.

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Microscopically, one of the pedunculated polyps of the colon showed the typical picture of a Grade I adenocarcinoma of the bowel.

Microscopic Study.—The heart, spleen, and pancreas showed no marked departure from normal. Microscopic examination of the adrenals showed a general atrophy in the thickness of the cortex and medulla, but the individual cells in both areas presented a normal appearance. The medulla seemed to have suffered the greater loss.

Sections of the kidneys showed marked vascular enlargement and some isolated areas of increased fibrous tissue, mildly infiltrated with lymphocytes, extending through the cortex. In and about an occasional glomerulus, there was also rather heavy lymphocytic infiltration, otherwise the glomeruli appeared normal. The tubules were somewhat dilated; the lining epithelium was flatter than usual; the cells contained colloid material, and the nuclei were absent from some. Some hyaline and fat droplets were found within the lumen of the tubules.

The sinuses of the liver, which were filled with blood, showed some dilatation. The cells, which were somewhat atrophic and slightly granular, presented a loss of cellular outline.

Following the microscopic discovery of carcinoma in the thoracic lesion, believed at autopsy to be an ancient, encapsulated empyema, sections were made from all portions of the hypertrophied prostate. It was felt that this gland might harbor a primary malignancy in spite of its benign gross appearance and negative routine sections. The findings were those described for prostatic enlargement of the simple type with glandular hyperplasia. In no portion was a malignant change suggested.

Because it was not enlarged or nodular and it had been clinically symptomless, the

thyroid was not sectioned. Unless it harbored a malignant growth, it seems that, in this case, we are dealing with a primary pleural malignancy of a peculiarly atypical and circumscribed character. Though endotheliomatous, the cellular picture is that of carcinoma.

DISCUSSION

It may be objected that, at autopsy, a small, primary tumor outside the thorax might have been overlooked. The thyroid was not removed because it was neither enlarged nor nodular, but all the other viscera were carefully examined for neoplasms. The stomach and small intestine, which were thoroughly inspected, showed no tumors, ulcers, or superficial erosions. The polyps in the colon were not ulcerated and did not exhibit signs of degeneration. There were no nodules or masses in the prostate, kidneys, adrenals, pancreas, spleen, or liver. The bladder wall was normal. The thymus had been almost entirely replaced by fat. Thus, with the possible exception of the thyroid, all probable sources of primary carcinoma outside the chest have been eliminated.

It is worthy of note that this man's symptoms were insignificant during the greater part of his illness. He was not confined to bed at any time because of his chest condition, and cough and expectoration were practically absent in spite of the fact that the disease was well advanced when he was first examined, six months before his death.

SUMMARY

A case of carcinoma is presented, probably primary in the pleura, which exhibited the roentgenologic and gross pathologic appearance of encapsulated empyema. It was recognized as malignant only by microscopic study of the lung and pleura.

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BONE (DIAGNOSIS)

The Calcaneal Spur. G. M. Sack. *Röntgenpraxis*, Feb. 15, 1932, IV, 158-167.

Spurs are exostotic bone growths on the plantar side (tubera calcanei) of the os calcis. Variations in the shape of the calcaneum and rims for the insertion of tendons should not be called "spurs." One may distinguish senile spurs—the formation of which usually begins between the ages of 40 and 50 years—which are caused by osteo-arthritic changes. This type is multiple, usually bilateral, and causes no symptoms.

Another type is a spur formation by inflammatory processes, occurring at any age and often unilateral. The primary cause is a bursitis and peribursitis calcanei through which a periosteal bone growth and spur formation take place. That certain diseases, as gonorrhea, are especially predisposing could not be

shown. Neither are deformities of the foot, such as flatfoot, a cause of spurs as often as has been thought. Trauma does not seem to induce them. All the symptoms are caused by inflammatory changes, either primary or secondary to the spur.

The therapy should be conservative, consisting of rest, roentgentherapy, combating the inflammation, and correction of foot deformities. Relief from symptoms is usually obtained in flatfoot by correction of foot deformities. In only a few cases is surgical removal indicated and advisable.

H. W. HEFKE, M.D.

A Rare Finding in Traumatic Lesions of the Elbow. Tullio Bertani. *Riv. di Radiol. e Fisica Med.*, March, 1932, IV, 347-350.

A man, 22 years of age, fell and injured his left elbow. A diagnosis was made of fracture of the

internal condyle of the humerus. Because of the position of the fragments, open suture was undertaken, and at the operation it was found that the lesion was really a fracture of a deposit of bone, which was most likely an inclusion of the epitrochlear nucleus in one of the tendon sheaths.

E T LEDDY, M D

BONE (THERAPY)

Fractures of the Lower Radial Epiphysis. William L. Watson. Arch Surg, March, 1932, XXIV, 492-504.

The author believes that even after adequate reduction of an epiphyseal fracture, a premature ossification with a resulting wrist deformity may ensue. A careful follow-up should be done on these patients over a period of at least two years. He advises that a conjugal chondrectomy be done as soon as a diagnosis of premature ossification can be made. This consists of excision of the conjugal cartilage of the ulna in order to produce cessation of its growth and thus avoid deformity of the wrist. The amount of longitudinal growth to be expected from the upper epiphysis of the radius is small, so the ulna should be excised at the level of the articulating surface of the radius. This excision of the ulna is a simple procedure and gives a well functioning wrist. If done early enough, it would probably prevent muscle weakness and atrophy.

HOWARD P DOUB, M D

The Role of Periosteum in the Healing of Fractures. An Experimental Study. Keene O Halderman. Arch Surg, March, 1932, XXIV, 440-450.

A number of theories have been evolved regarding the rôle played by the various components of bone in the healing of fractures. The author has summarized these theories from the works of Bancroft. They are as follows: (1) Periosteal theory—this presupposes that the periosteum and endosteum are definite organs for bone formation in repair, and that the bone cells arise from them and from no other source, (2) osteoblastic theory—this assumes that there are definite bone cells which take up the function of repair, (3) the theory of the extracellular deposition of calcium salts assumes that there is chemical repair without any definite bone producing cells.

The author conducted a series of experiments on animals under the following groups: (A) Saw cut in each radius, stripping the periosteum on the left, (B) segment removed from each radius, stripping the periosteum on the left, (C) segment removed from each radius, drawing the periosteum over the ends of the right radius, (D) segment removed

from each fibula of a dog, drawing the periosteum over the ends of the right fibula.

From the above experimental procedures, the author draws the following conclusions: (1) Periosteum plays the chief rôle in the healing of fractures, (2) endosteal callus aids in the healing of fractures, but in the absence of periosteum is often unable to complete the union, (3) the interposition of periosteum between the ends of the fractured bone may result in non-union.

HOWARD P DOUB, M D

Fractures of the Upper End of the Humerus. An End result Study which Shows the Advantage of Early Active Motion. Sumner M Roberts. Jour Am Med Assn, Jan 30, 1932, XCVIII, 367-372.

These fractures are defined as those at or above the level of the surgical neck of the humerus. The data used were gathered from the records of the fracture service at the Massachusetts General Hospital. The patients were treated by three different services: two surgical and one orthopedic, and by a considerable number of different surgeons, all agreeing on the main principles of procedure. The results are grouped under the headings of anatomic, economic, and functional.

Classification on anatomic lines is sometimes in convenient and difficult. A division into two groups, transverse fractures of the surgical neck and comminuted fractures, obviates uncertainty of exact location and accords with different lines of treatment. Compared with ten years ago, there has been a marked trend away from prolonged fixation and the position of abduction toward simple fixation and early active motion. The end-results of such treatment are good.

C G SUTHERLAND, M D

BONE DISEASES (DIAGNOSIS)

Aseptic Necrosis of the Neck of the Femur in Adolescents. Osteochondritis Juvenilis of the Neck of the Femur. G Gütig and A Herzog. Röntgenpraxis, June, 1932, IV, 504-513.

The aseptic necrosis of the neck of the femur in adolescents may be compared with Calvé Legg-Perthes' disease of the head of the femur. Many cases of coxa vara in young persons may be explained by it. Aseptic areas of necrosis are found in the neck of the femur or the major trochanter. Clinical symptoms are limping or other disturbances in the gait. Pain is not present or localized. Several such cases are described in detail and roentgenograms of them shown. The pathologic anatomy, genesis, therapy, final outcome, and therapy are discussed. The difference of this disease from Legg-

Perthes' disease is the localization. Tuberculosis, separation of the epiphysis, and fracture of the neck must be considered occasionally in differential diagnosis.

H. W. HEFKE, M.D.

Generalized Osteitis Fibrosa Cystica Associated with a Parathyroid Adenoma. T. P. Noble. Jour. Bone and Joint Surg., January, 1932, XIV, 181-185.

The author reports from Bangkok, Siam, what he believes to be the eighteenth recorded case of generalized osteitis fibrosa cystica in which there was a demonstrable parathyroid adenoma. The tumor was not demonstrated at operation but was found at autopsy.

PAUL C. HODGES, M.D.

So-called Fibrosarcoma of Bone: Bone Involvement by Sarcoma of the Neighboring Soft Parts. Charles F. Geschickter. Arch. Surg., February, 1932, XXIV, 231-291.

The author states that while this group of tumors usually has a structure indicating a connective tissue origin, the current conception that these fibrosarcomas which invade the bone are all products of the non-osteogenic layers of the periosteum is erroneous. They vary considerably as to origin, and may arise either from this investing portion of the periosteum or from a similar connective tissue or fascia, investing muscles, vessels, or nerve trunks in the overlying soft parts.

He classifies these tumors under the following headings: (1) Tumors of the fibrospindle cell group; (2) neurogenic tumors, involving the bone; (3) osseous invasion by miscellaneous tumors of connective tissue origin—(a) angioma of bone, (b) myosarcoma and lipoma.

Fibrospindle Cell Group.—This is a disease of adult life occurring most frequently beyond the age of thirty. The lower extremity is usually the site of predilection, the region of the femur being most often involved. The swelling is smooth in contour and differs from the ordinary type of soft sarcoma in the depth of its location and its firm attachment to the underlying bone. The interference with function is also more rapid in the affected limb because of its proximity to the bone. An unusual feature of this disease is that the growth, when occurring near the end of the bone, may extend across the joint and involve the neighboring bone. Metastases to lymph glands have not been found. It is somewhat similar to other forms of sarcoma of bone in its general characteristics and location, but tends to destroy the bone from without inwardly. The one constant feature in the roentgenogram is this extra-osseous soft shadow which is more opaque than the cartilaginous masses seen in periosteal chondrosarcoma, and less

dense than the true bone formations seen in osteogenic sarcoma. Considerable bone destruction is frequently seen, but only occasionally is a calcareous deposit seen in a tumor. The size of the soft-part tumor which exceeds the area of bone destruction is a helpful diagnostic point. This is usually large before much evidence of bone destruction is found.

At operation the tumor is usually encapsulated, is firm and fibrous in consistency, and often has a definite peculiarity of being arranged in whorls and strands which run in a number of diverging directions.

The tumor springs from a small spindle- or oat-shaped cell which transforms into a more elongated, spindle-shape and then into a prolonged fibroblast, with an ever increasing amount of intercellular material of the eosin-staining collagenous type. The author goes into the microscopic anatomy in considerable detail.

In 22 cases, none of the patients died within a period of five years after treatment; and in all cases of primary amputation in which adequate follow-ups were available, the patients were cured and were living from six to twelve years after operation.

The tumor is not particularly radiosensitive, and after a local operation followed by roentgentherapy and radium, it has usually recurred. Radiation therapy, however, is recommended in cases in which a complete resection is not possible.

Neurogenic Tumors Involving Bone.—He describes a series of cases which could be specifically related to the nerves in the vicinity of bone. Clinically and in the roentgenogram, these neurogenic tumors bear close resemblance to the lesions of the fibrospindle cell series just discussed. Like the fibrosarcomas, the neural tumors may have a marked fibrillar structure and show under the microscope many spindle cells. Very frequently the differential diagnosis between the fibrospindle cell type and the neurogenic type is not made.

The bone involvement, as shown in the roentgenogram, is more pronounced in the neurogenic sarcoma than in the fibrospindle cell sarcoma. There is frequently considerable osteolytic bone destruction. The tumors are less firm and more fleshy than the fibrospindle cell sarcoma.

The prognosis for life, in cases of neurogenic sarcoma, even after primary amputation, is not good. These tumors recur promptly after local operation, and are not radiosensitive. There is only one cure in this series, extending over five years. This bad prognosis is in marked contrast to the results obtained in the group of fibrosarcomas described in the previous division.

Angioma of Bone.—Three benign hemangiomas of bone are described. They simulate, in the roentgenogram, a peculiar soap-bubble effect extending into the periosteal zone and producing only slight erosion of the bone. At operation, a thin bone shell was

found, and the tumor beneath had the appearance of an altered blood clot. These occurred in adults over 20 years of age, with a history of trauma in each case. Under the microscope, the three cases showed histologic variation characteristic of the benign hemangiomas that are found in the soft parts and subcutaneous tissues. All were operated on by local excision with complete cure and no metastases.

Myosarcoma and Lipoma.—The author reports one case of myosarcoma of the lower end of the left femur. The patient had local excision several times, and died three years and four months after amputation, with pulmonary metastases.

The other patient was a girl, 15 years of age, with a swelling of one month's duration in the region of the knee joint. Roentgenograms showed a soft part swelling slightly eroding and roughening the internal condyle of the femur. A section showed a typical, benign lipoma. This was excised by local operation.

HOWARD P. DOUB, M.D.

Spontaneous Fracture (Carcinomatous Metastasis) of the Dens Epistrophei without Compression of the Spinal Cord. H. Hamperl and A. Maller. *Wien. klin. Wchnschr.*, Jan. 1, 1932, XLV, 24-27.

In a 74-year-old patient there occurred a spontaneous fracture of the dens epistrophei, caused by a metastasis from a prostatic carcinoma. There was a marked dislocation of the skull from the cervical spine. Neither clinically nor during autopsy could any lesion of the central nervous system be demonstrated. Cases of this type are exceedingly rare and seldom described.

H. W. HEFKE, M.D.

BONE DISEASES (THERAPY)

Roentgentherapy of Osseous Metastasis from Carcinoma of the Breast. Lorenzo Feci. *Archivio di Radiologia*, January-February, 1932, VIII, 5-14.

The author reports a case of osteoclastic metastasis to the frontal bone from an adenocarcinoma of the breast which had been operated on three years previously. The patient had had one course of both pre- and post-operative roentgentherapy. X-ray treatment at high voltage through an anterior and lateral field produced a disappearance of symptoms, which has lasted for two years. The author emphasizes the great radiosensitivity of osseous metastasis and advances as a theoretical explanation for it that the irradiation might have decreased the virulence of the cells in the metastasis.

E. T. LEDDY, M.D.

Quick Healing of Bone Atrophy after Roentgen Irradiation. H. Eckstein. *Med. Klinik*, Sept. 11, 1931, XXVII, 1353.

Some years ago the author reported the disappearance of pain in his hip after a diagnostic exposure. He observed the quick beneficial effect of small doses of X-rays in a woman with marked bone atrophy of the left leg and femur after a thrombosis in the left leg. One-fourth of an erythema dose of soft rays was given, with immediate good results, while previously the progress had been very slow. Five weeks after the irradiation the bones showed a normal appearance.

H. W. HEFKE, M.D.

CANCER (DIAGNOSIS)

Case Report; Primary Carcinoma of the Lung, with Metastases. Tobias B. Weinberg and Henry Friedland. *Jour. Am. Institute Homeopathy*, April, 1932, XXV, 415-420.

The authors report the case of a man, 55 years of age, who complained of persistent cough, with profuse expectoration, dyspnea, fatigability, loss of weight, swelling of the ankles, and precordial pain. Six years prior to admission, because of dyspnea and precordial pain, he consulted a physician, who made a diagnosis of asthma and chronic bronchitis. About two weeks before admission the patient had a moderate hemoptysis.

Physical examination was essentially negative, except for moist râles which were heard posteriorly over both lungs at the angles of the scapulae. Radiographic examination showed a dense circular shadow adjacent to the mediastinum on the left side at the level of the auricle, which was suggestive of a neoplasm apparently originating from the mediastinum. Two months later, X-ray examination revealed evidence of metastatic carcinoma in the left parietal region of the skull. A roentgenogram made of the chest about three months after admission showed the presence of a large amount of fluid in the left chest which obscured the shadows of the mass.

Bronchoscopic examination at about this time showed the inferior wall of the left main bronchus to be displaced upward, which gave the impression of an extra-bronchial neoplasm. Clinically, the patient's symptoms became progressively worse and death followed. Postmortem examination showed the presence of a large mass in the external region of the lower lobe of the left lung, with metastatic lesions in the adrenals, kidney, pancreas, mesenteric lymph nodes, and skull.

J. N. ANÉ, M.D.

LIPIODOL (LAFAY) in Chest Roentgenology

1
Roentgenogram before injection: Appearance practically normal.

2
After LIPIODOL injection: A bronchiectatic abscess in right lower lobe previously invisible.

Photographs by
Courtesy Dr. David
H. Ballon, Montreal



Functions of Lipiodol (BALLON)

(ARCH. OTOLARYN, 33: 1926)

- 1 Topography of normal trachea and bronchi is clearly shown in contrast to pathologic.
- 2 Bronchial stenosis is recognizable.
- 3 True lung abscess is readily differentiated from bronchiectatic abscess.
- 4 Bronchiectasis is diagnosed at a glance.
- 5 In pulmonary tuberculosis cavities are localized.
- 6 Bronchial fistulas and empyema cavities are clearly defined.
- 7 The thoracic surgeon has a useful means of deciding whether or not to operate, the extent of operative interference and the prognosis.



SANTE in volume eleven of "Annals of Roentgenology" (Hoeber, New York), in discussing the use of iodized oils, cites Lipiodol, an iodized oil containing 40% combined pure iodine in poppy-seed oil, "as a medium opaque to the roentgen ray owing to its high iodine content, non-irritating and devoid of any toxic effect on account of the slow liberation of iodine in assimilable form."

Procedure for Intratracheal Injection

There are three methods employed for introducing Lipiodol into the broncho-pulmonary apparatus: (1) supraglottic, (2) bronchoscopic and (3) intercricothyroid. Sante recommends the following technique. Patient sits in upright position facing operator. After pharynx and larynx are anesthetized with cocaine or novocaine, patient is instructed to grasp tongue with piece of gauze and pull it forward. Oil previously warmed to body temperature is dropped into the glottis while cords are open. If right lung is to be filled, patient leans to right; if left lung is to be examined, patient is inclined to left.

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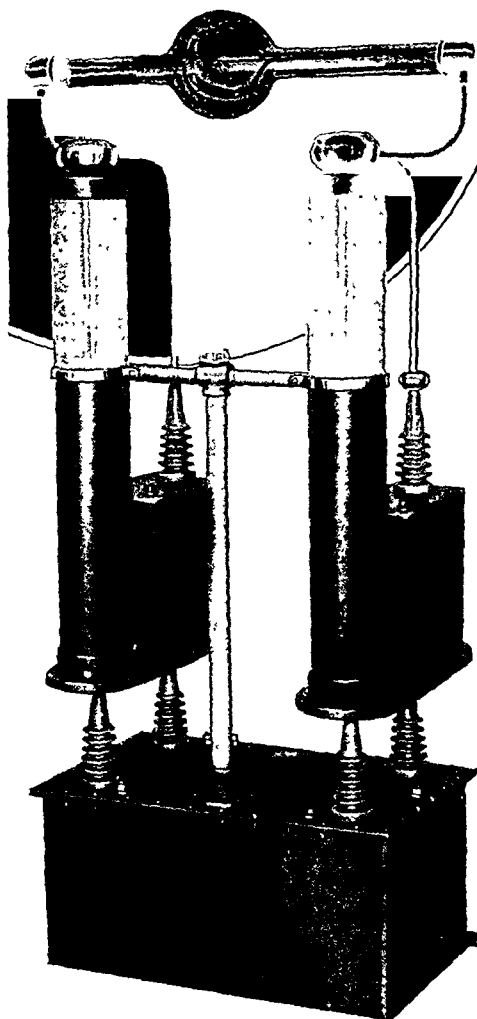
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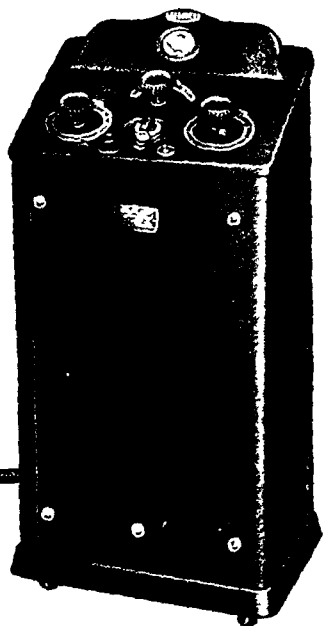
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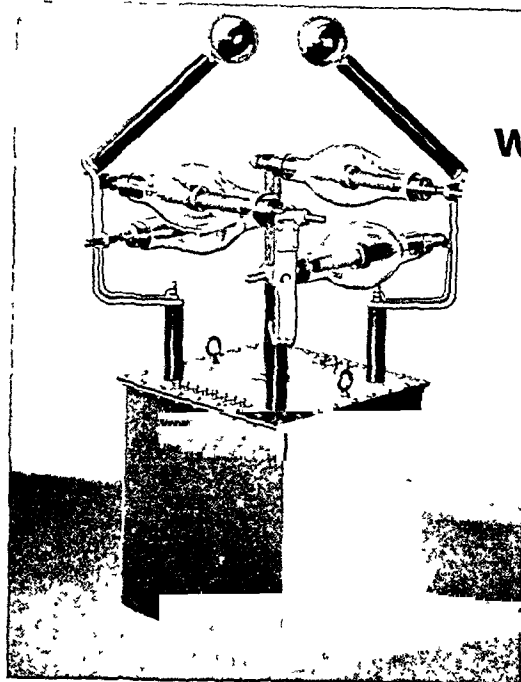
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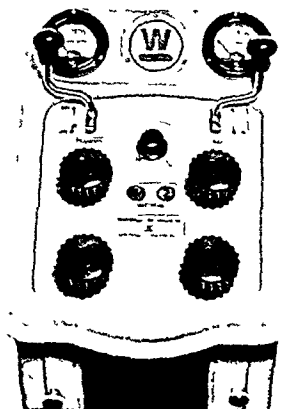
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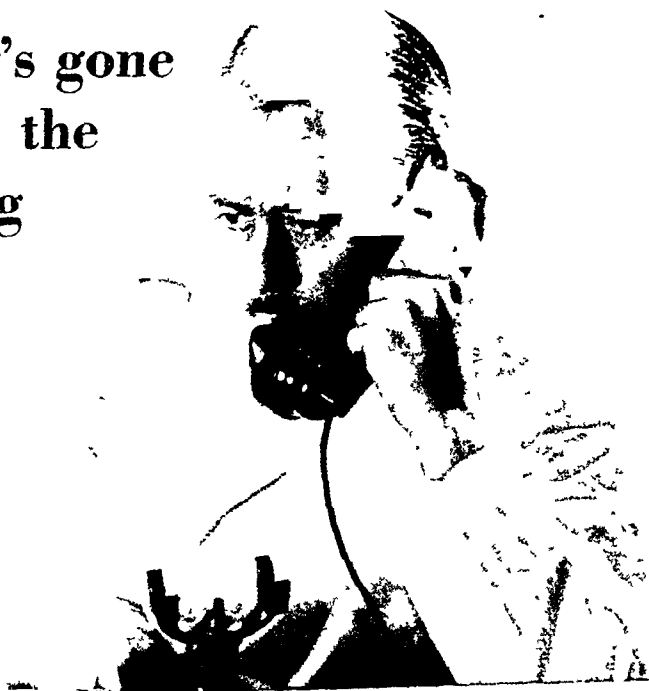
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